

RICH PID studies

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Italian Analysis meeting, 16 March 2018

Outline

Clarification on:

- **Study of the RICH PID efficiency(ies) of 2016 pinunu analysis and its breakdown (presented at the Collaboration meeting in December 2017)**

https://indico.cern.ch/event/686789/contributions/2822228/attachments/1575966/2488748/roberta_pinunu_december.pdf

- **Study of the correlations and first try to optimize RICH PID via TMVA (presented at the Collaboration meeting in March 2018)**

https://indico.cern.ch/event/711767/contributions/2925938/attachments/1613113/2562334/roberta_richpid_pinunu_march.pdf

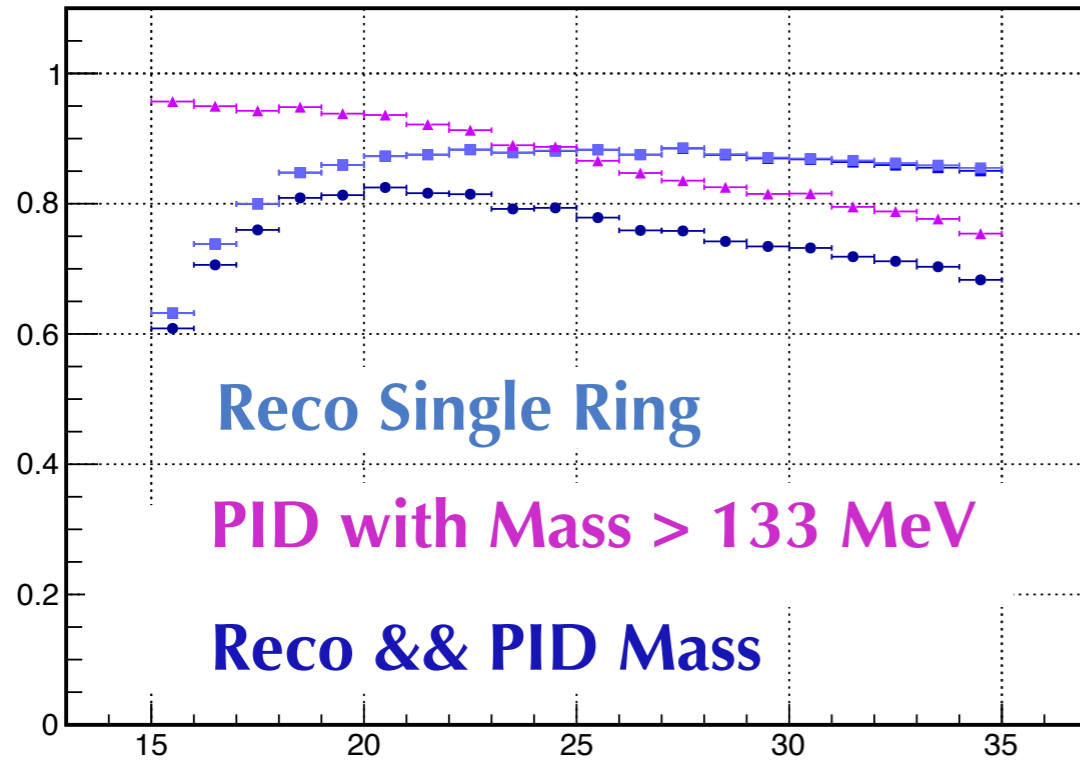
- **Correlation of variables used now**
- **Cut on likelihood**
- **Study of maxdeltaphi**

Samples and selection

- **Full 2016A**
- **Pnn filter**
- **Analysis framework by Giuseppe with my modifications to study the PID.**
- **I have removed the cut on the $P(\chi^2)$ for the single ring.**
- **I implemented new trees in the “Giuseppe framework” and use them as input of a second step analyzer where I call TMVA for training and testing.**
- **Calorimeters PID cuts on CaloMVA**

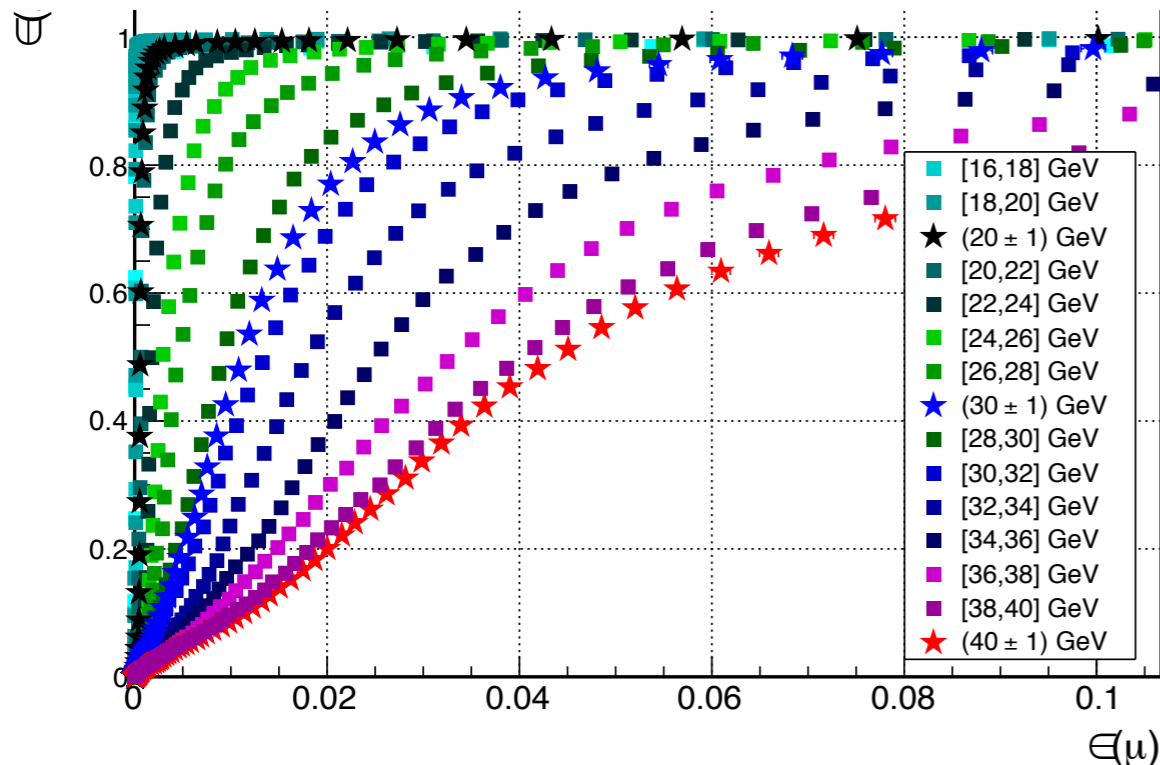
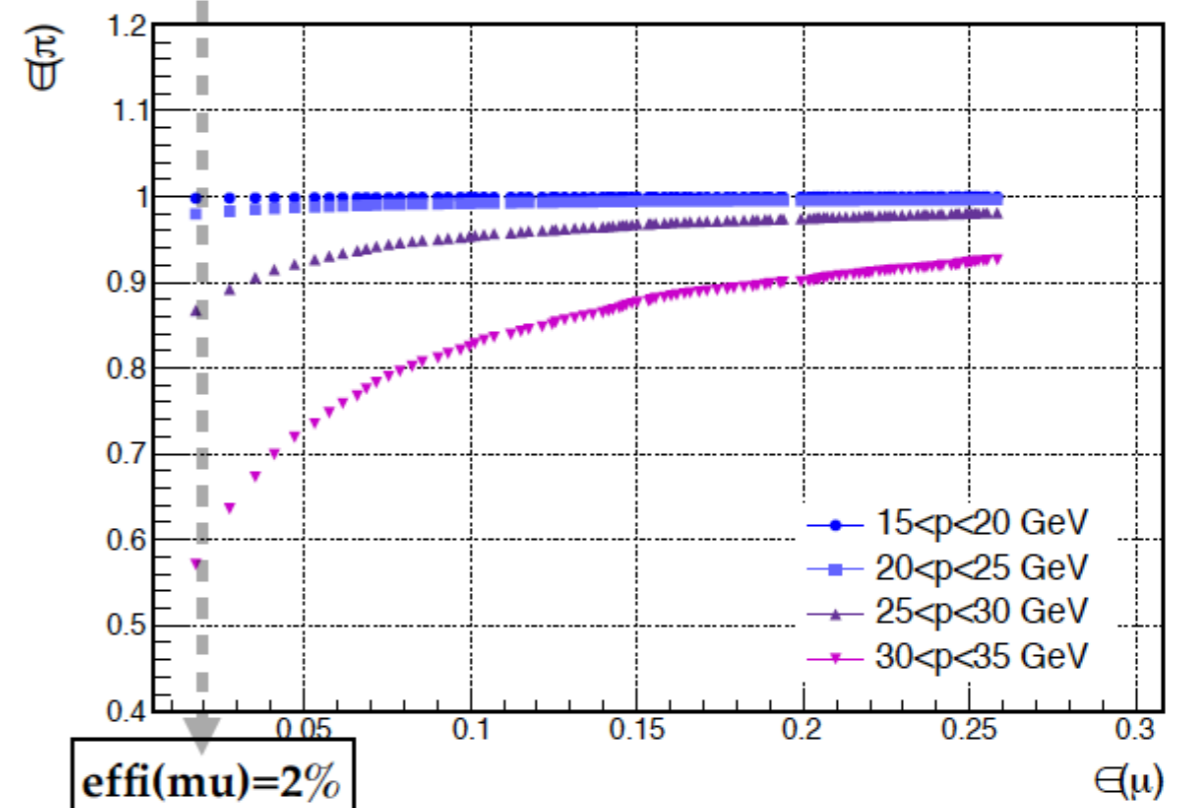
Current analysis

Pion ID efficiency vs track momentum



- Single ring reco
- MostLikelyHypothesis=pion
- $L(\text{pion})/\max(L(\mu),L(e)) > 1.2$
- Mass > 133 MeV

Pion/muon separation with cut on $\max(L_e, L_{\mu})/L(\pi)$



Remove the cut on $P(\chi^2)$

Current analysis

$\text{effi}(\text{PiP0}) = 0.753$ (including Ring Reco efficiency = 0.884)

$\text{effi}(\text{PiP0}) = 0.852$ $\text{effi}(\text{Kmu2}) = 0.00253$ Only PID efficiency

Removing the cut on χ^2 probability:

$\text{effi}(\text{PiP0}) = 0.817$ (including Ring Reco efficiency = 0.967)

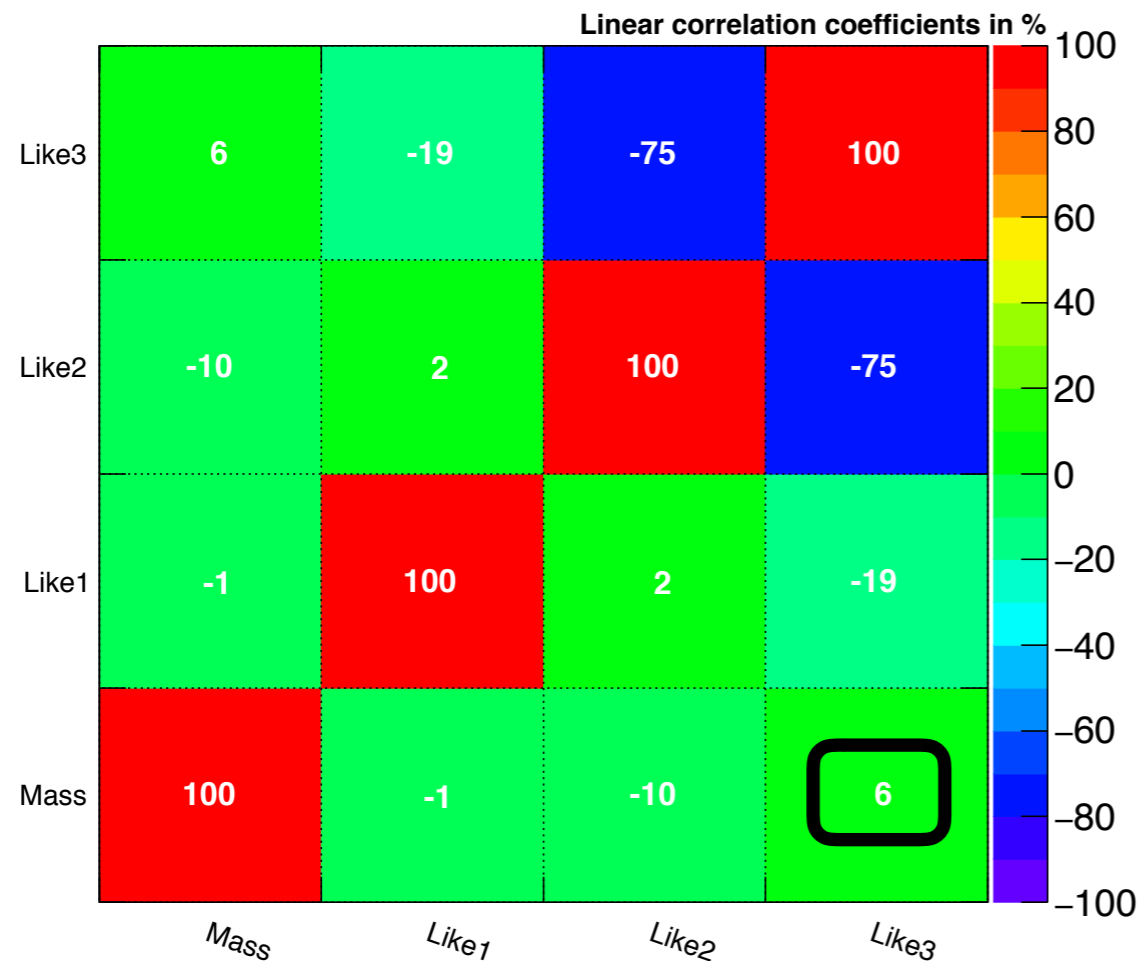
$\text{effi}(\text{PiP0}) = 0.844$ $\text{effi}(\text{Kmu2}) = 0.00363$ Only PID efficiency

now:	$\text{effi}(\text{PiP0}) = 0.753$	$\text{effi}(\text{Kmu2}) = 0.00253$
No cut on χ^2 :	$\text{effi}(\text{PiP0}) = 0.817$	$\text{effi}(\text{Kmu2}) = 0.00363$

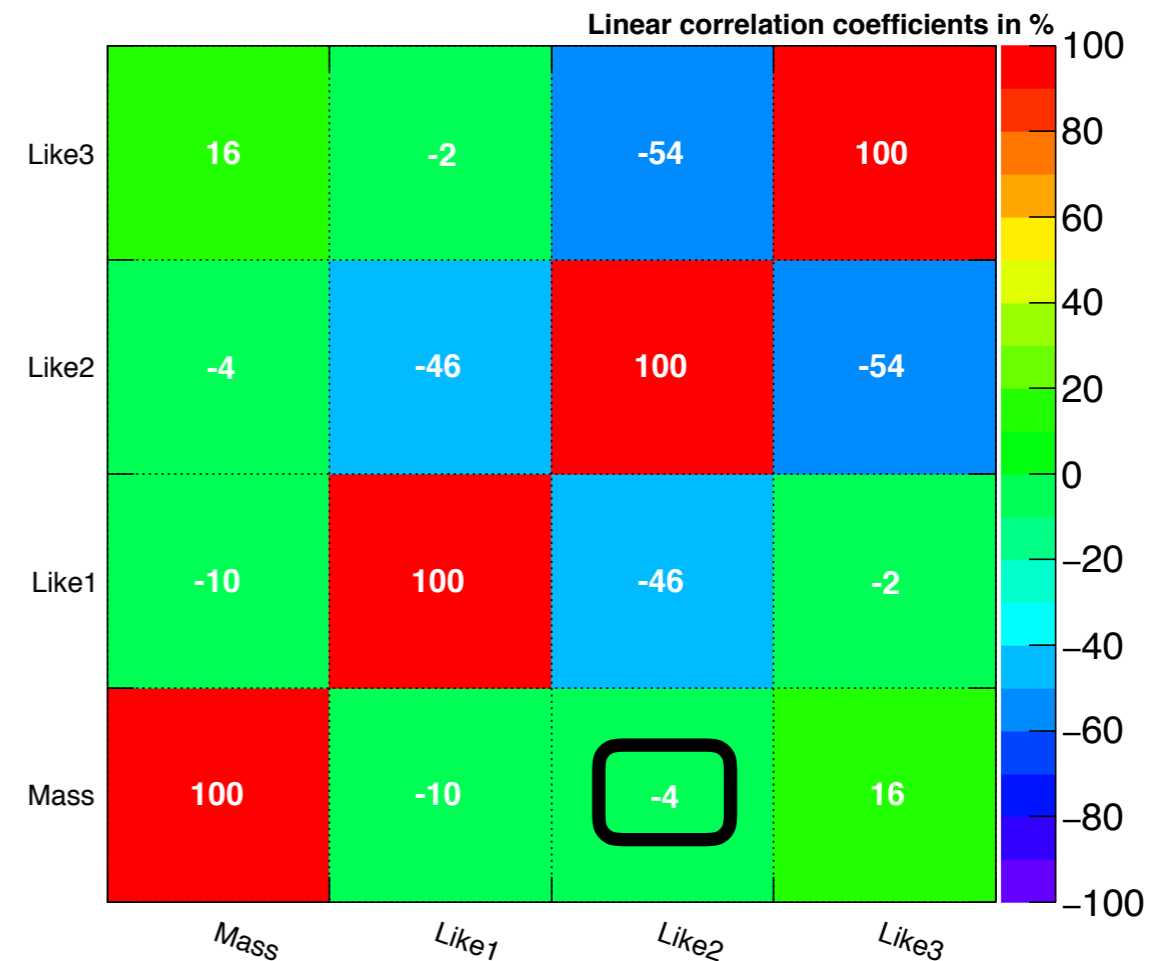
LINEAR correlations

Like1= RICHLikelihood(e)
Like2= RICHLikelihood(mu)
Like3= RICHLikelihood(pion)

Correlation Matrix (signal)



Correlation Matrix (background)



It's just a linear correlation coefficient
I should use $|m-m(\text{pi})|$ and $|m-m(\text{mu})|$
to get larger correlation coefficients

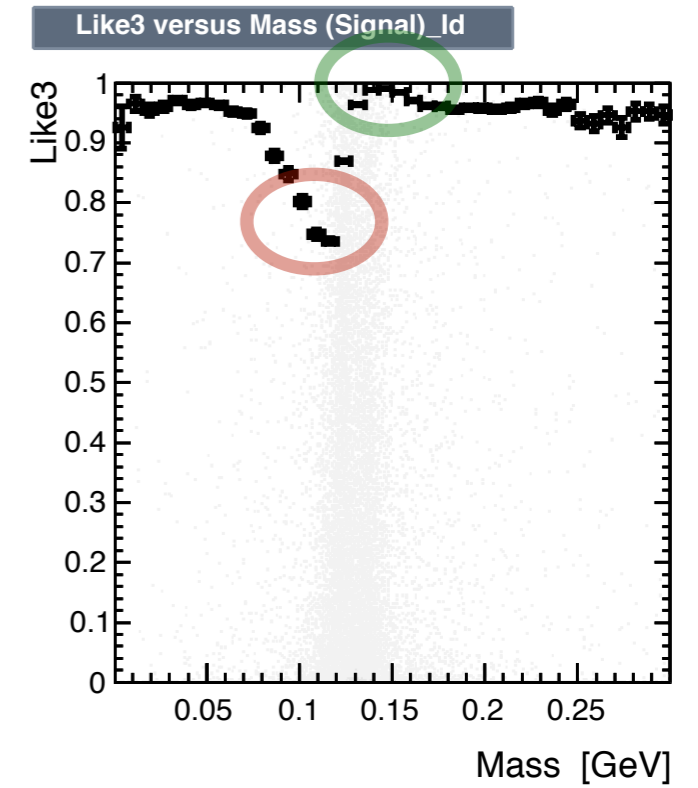
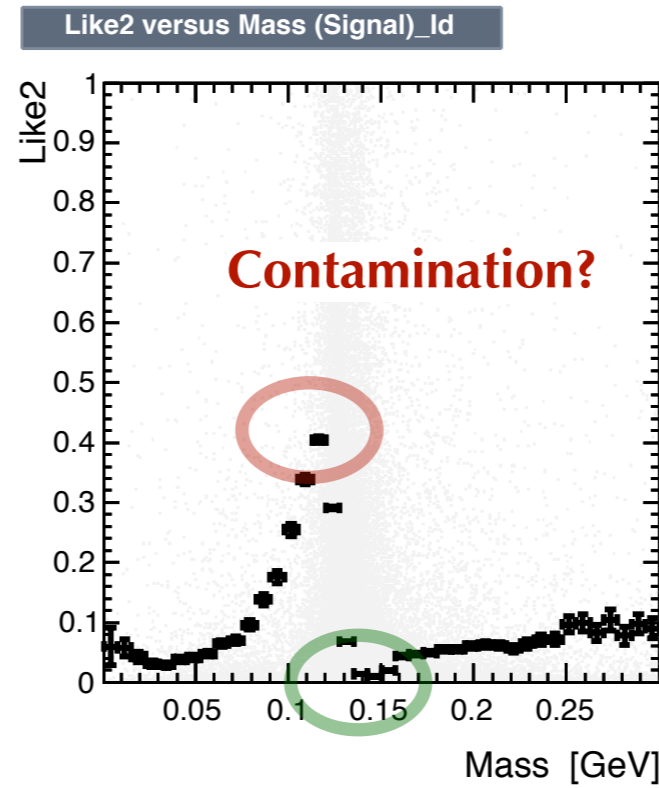
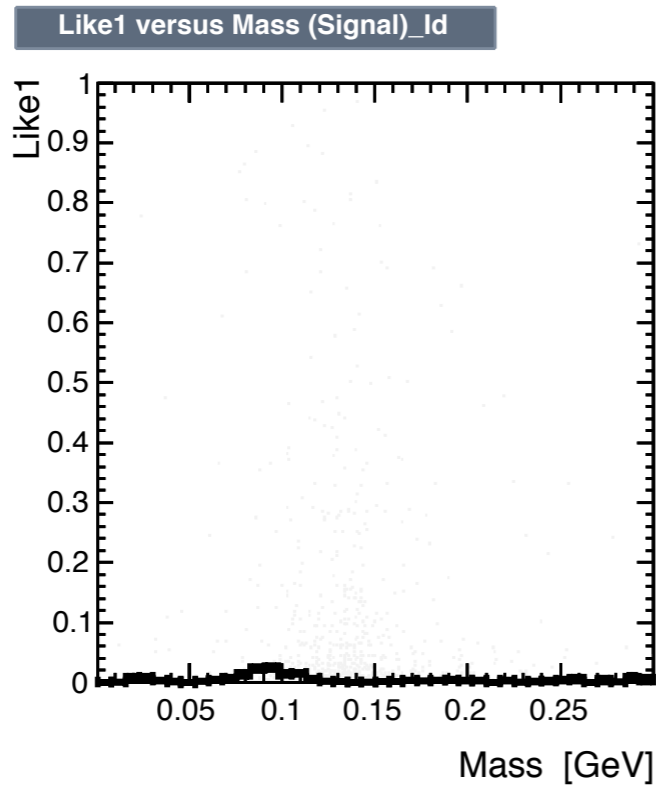
correlations

L(e)

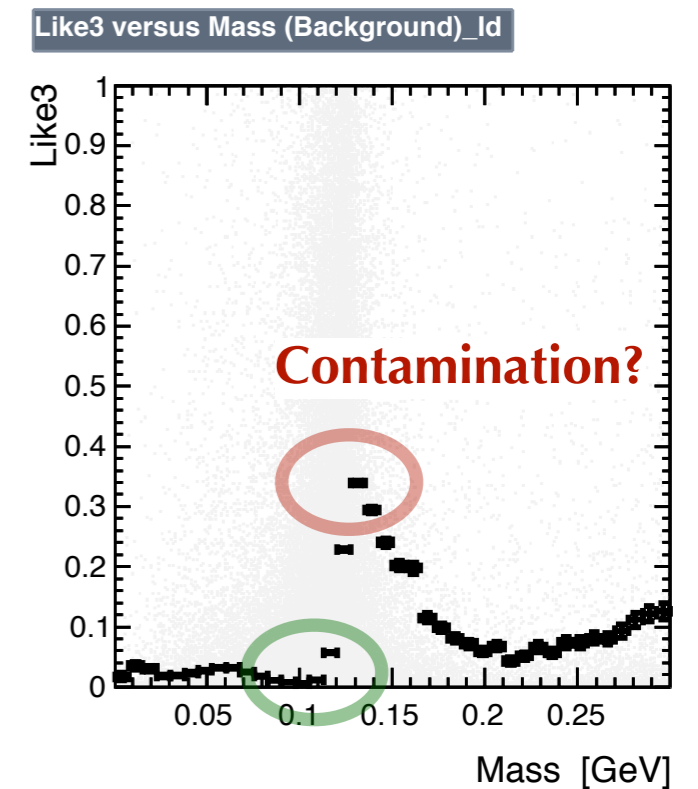
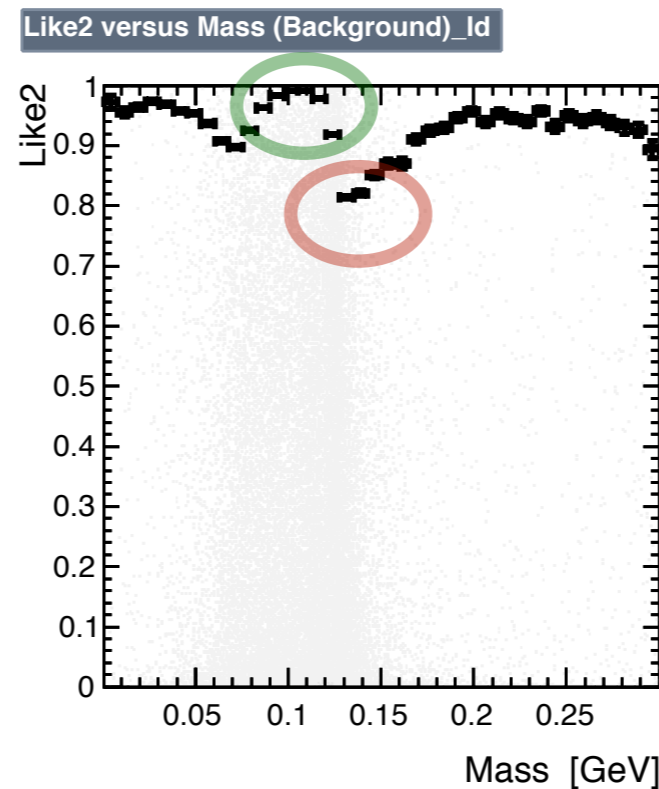
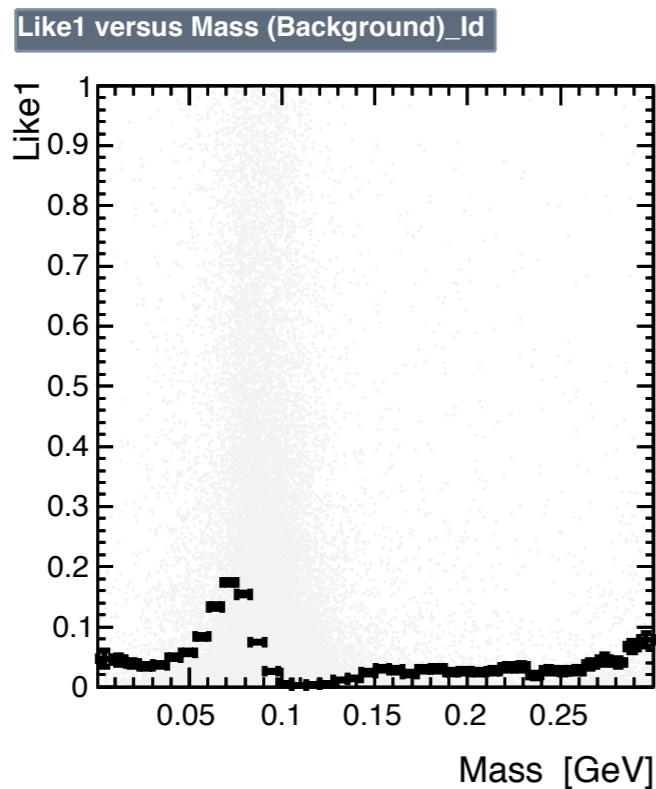
L(μ)

L(π)

π



μ

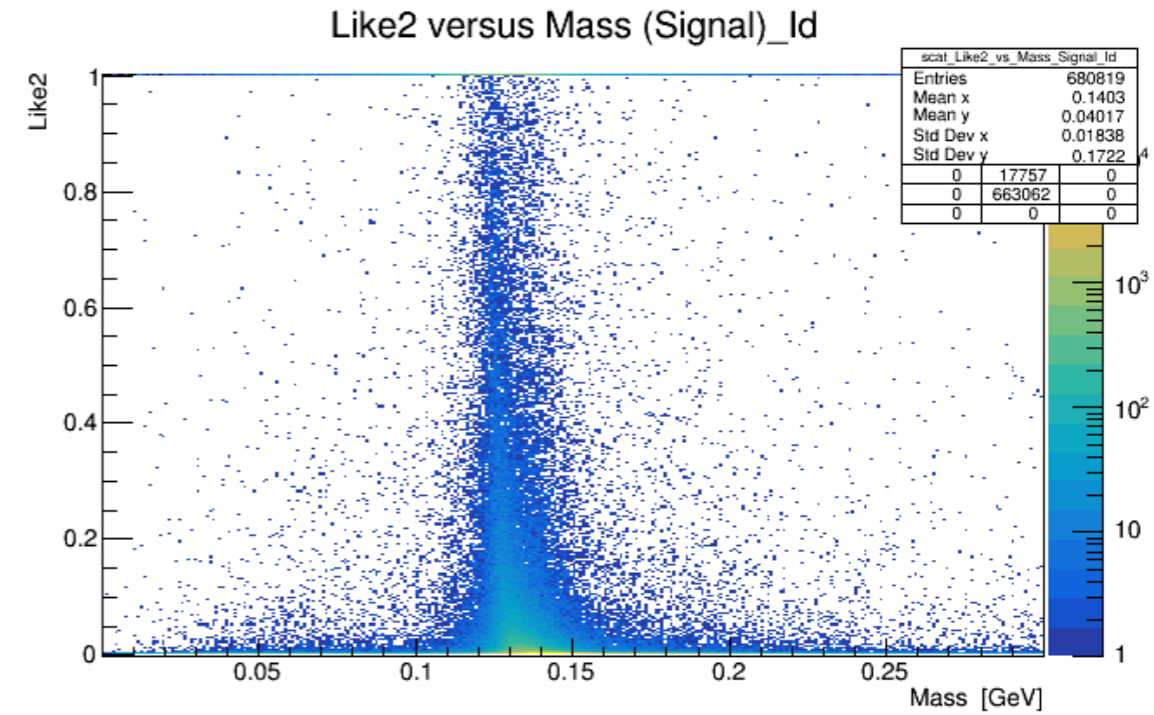
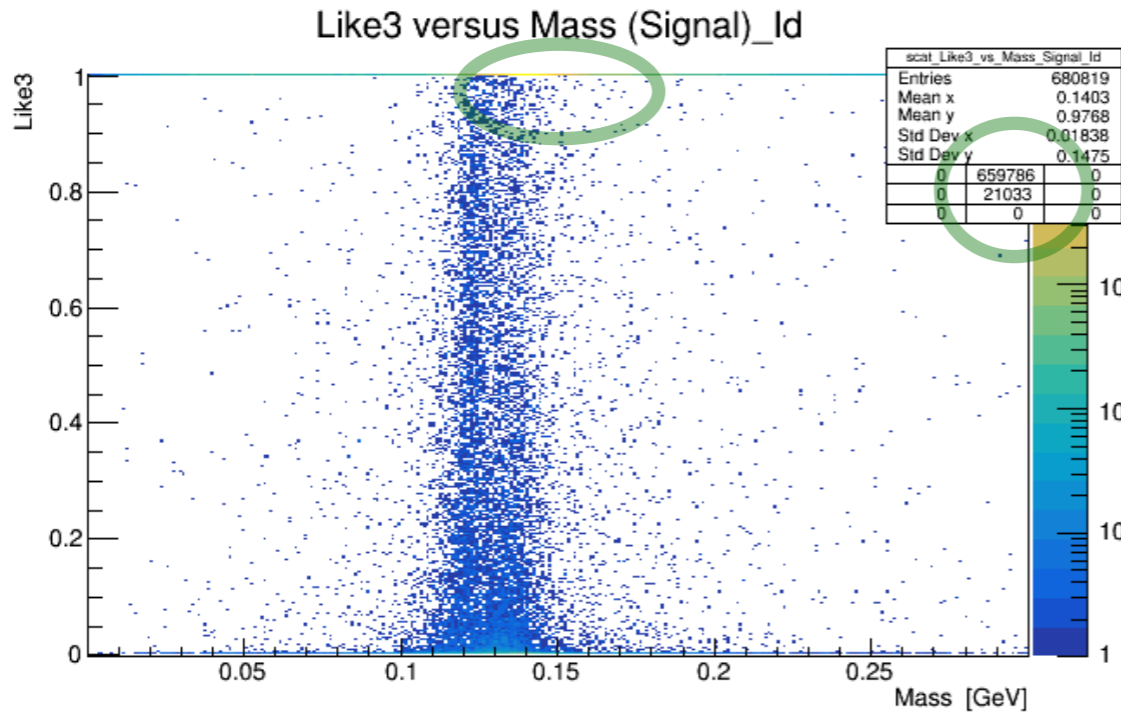


correlations

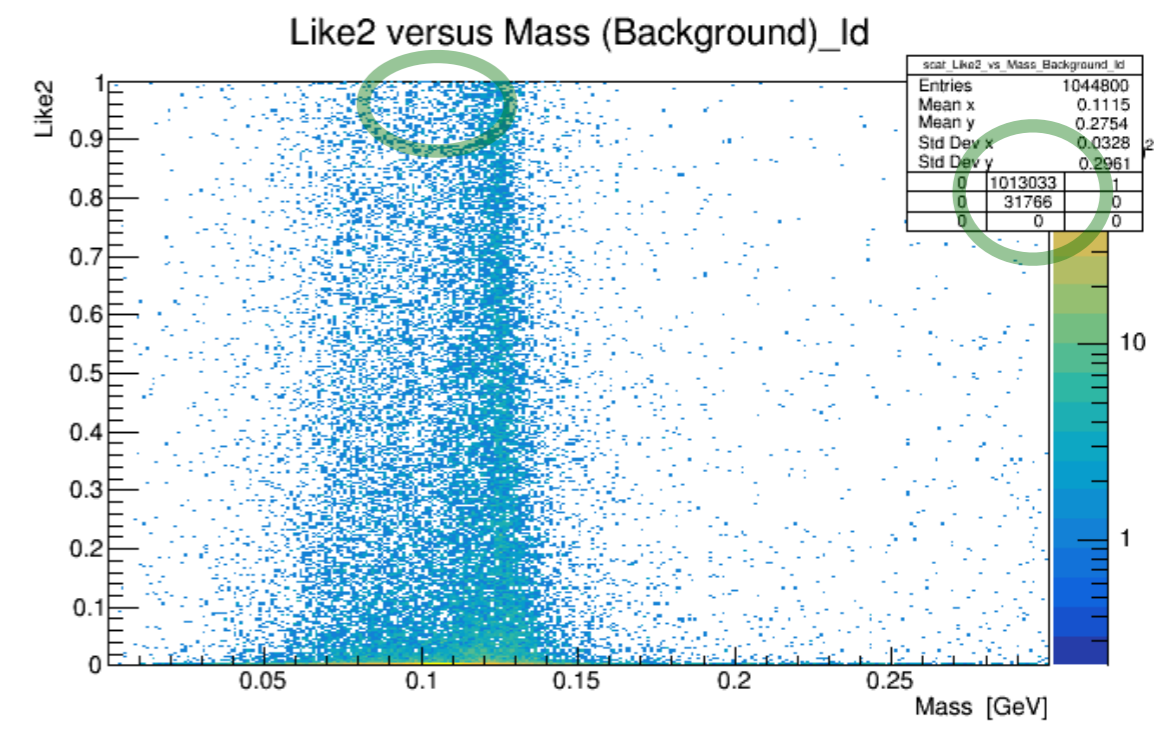
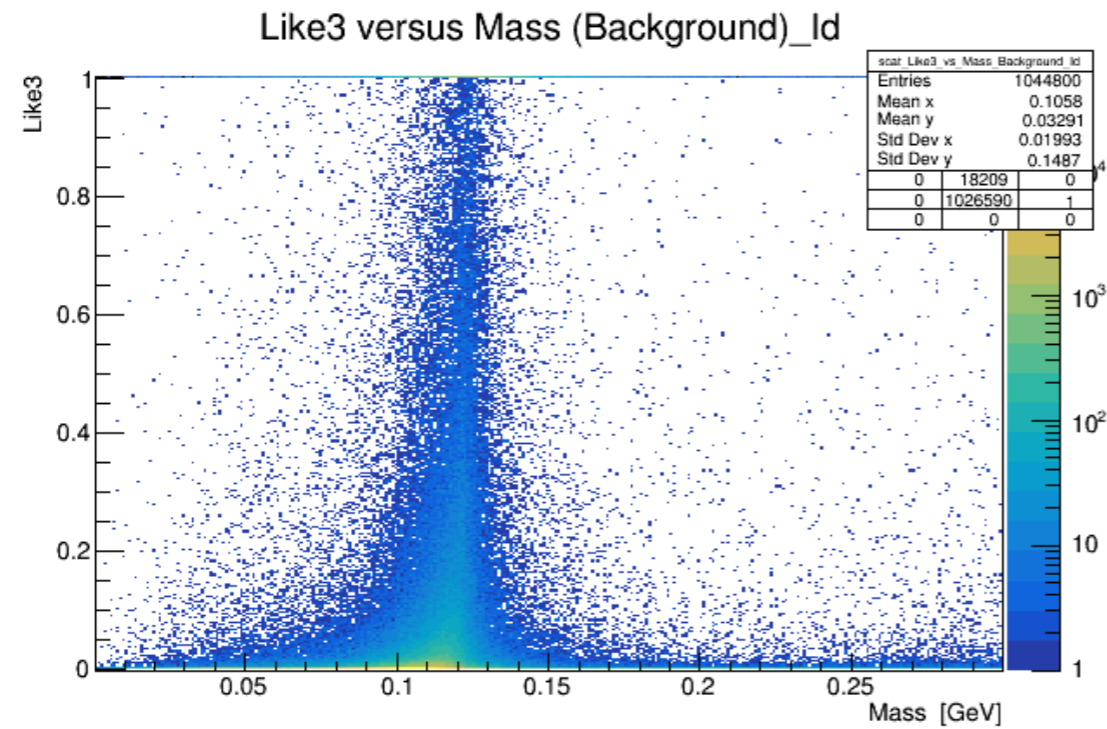
$L(\pi)$

$L(\mu)$

π



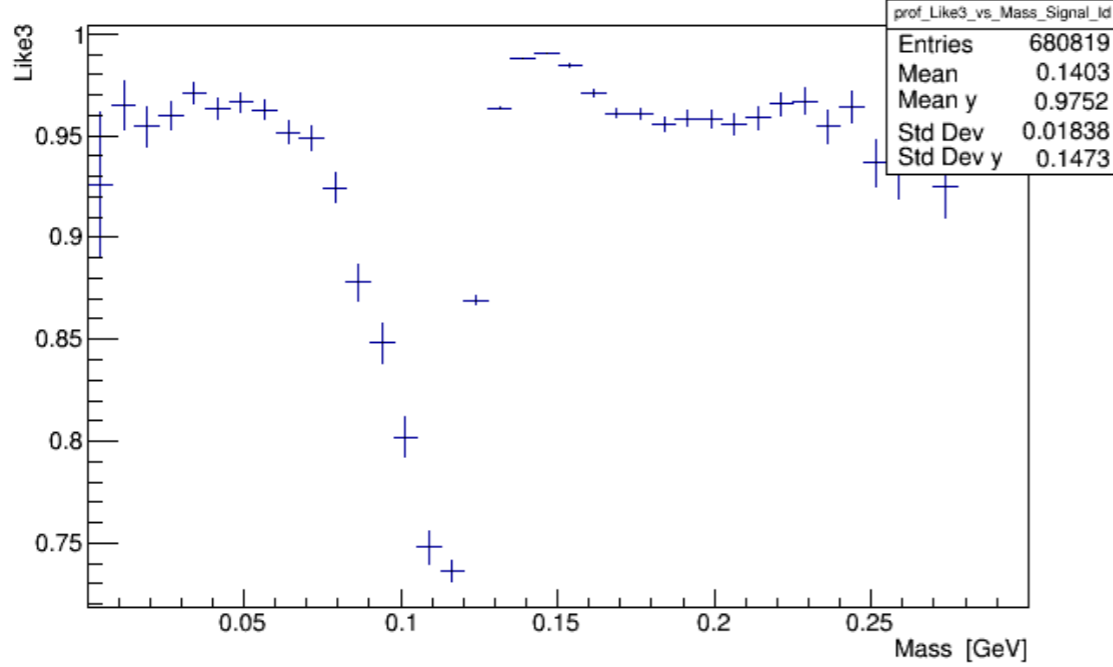
μ



correlations

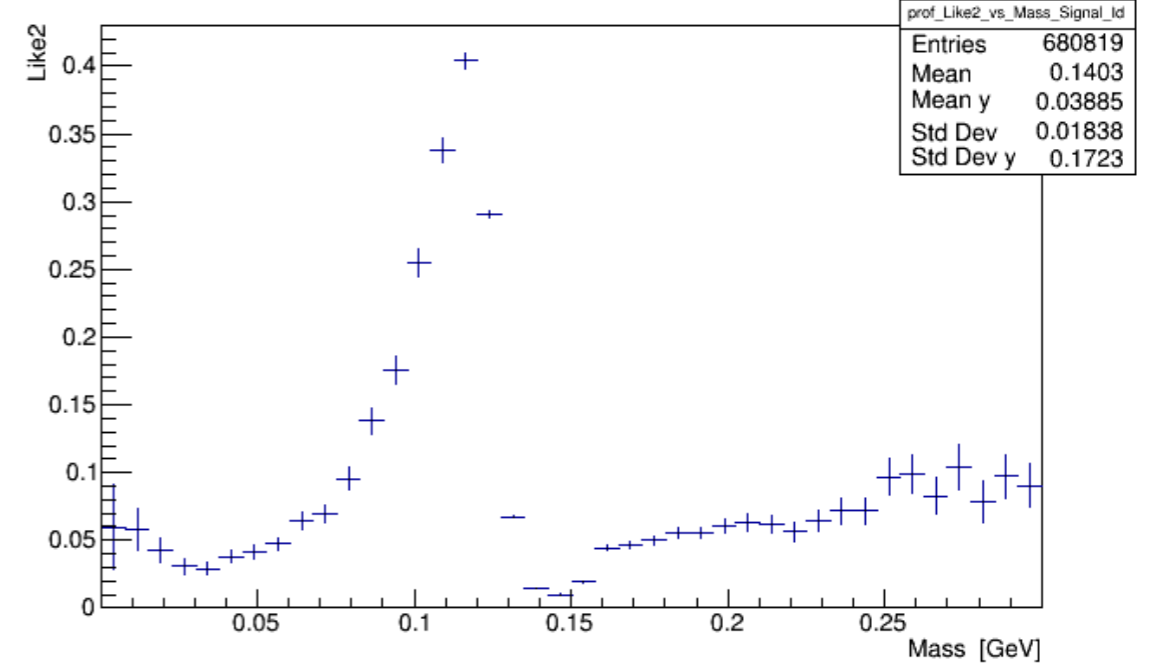
$L(\pi)$

profile Like3 versus Mass (Signal)_Id



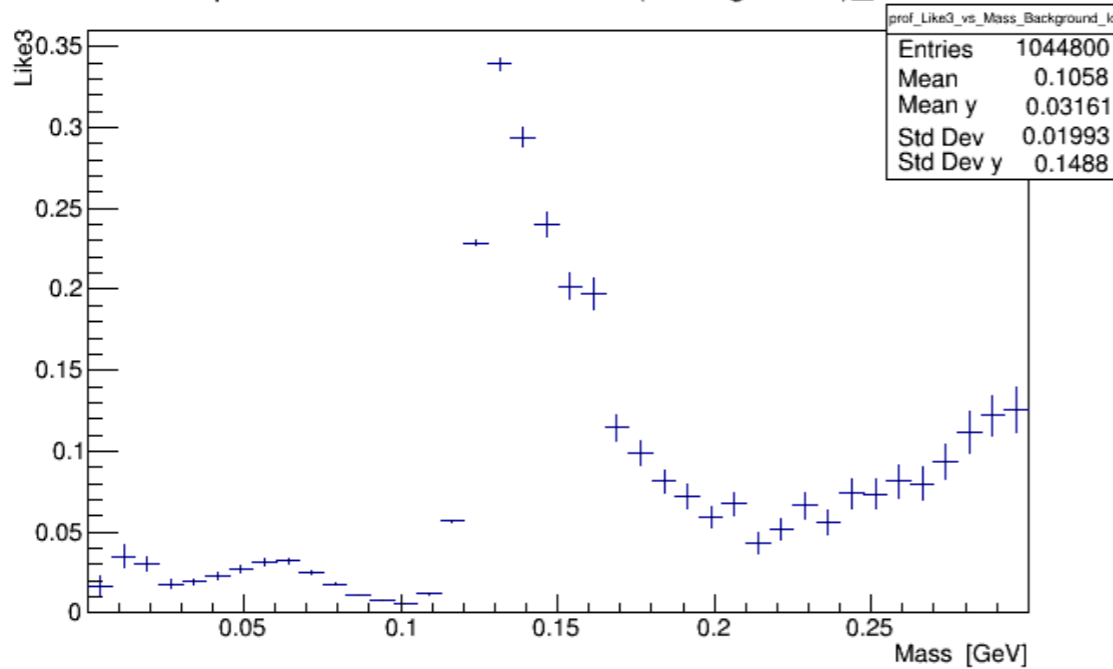
$L(\mu)$

profile Like2 versus Mass (Signal)_Id

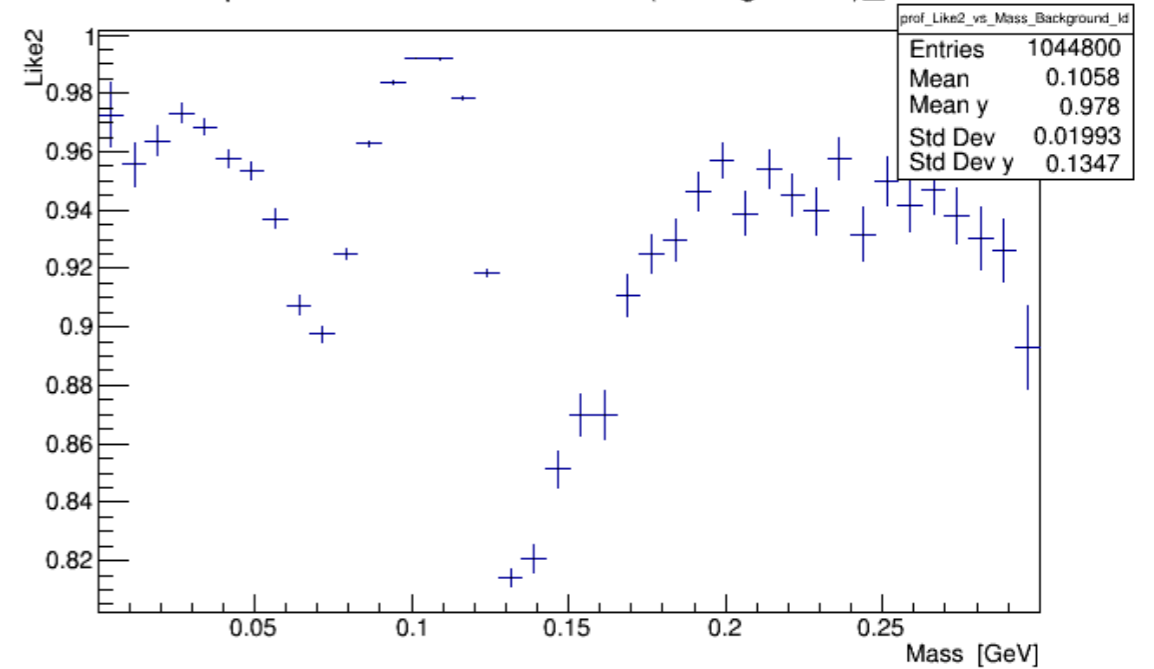


π

profile Like3 versus Mass (Background)_Id

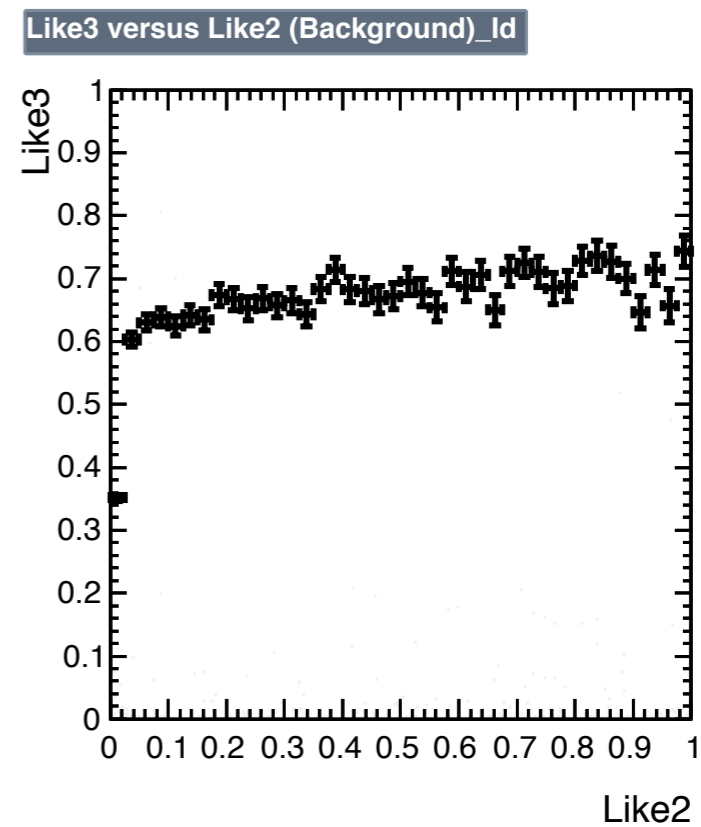
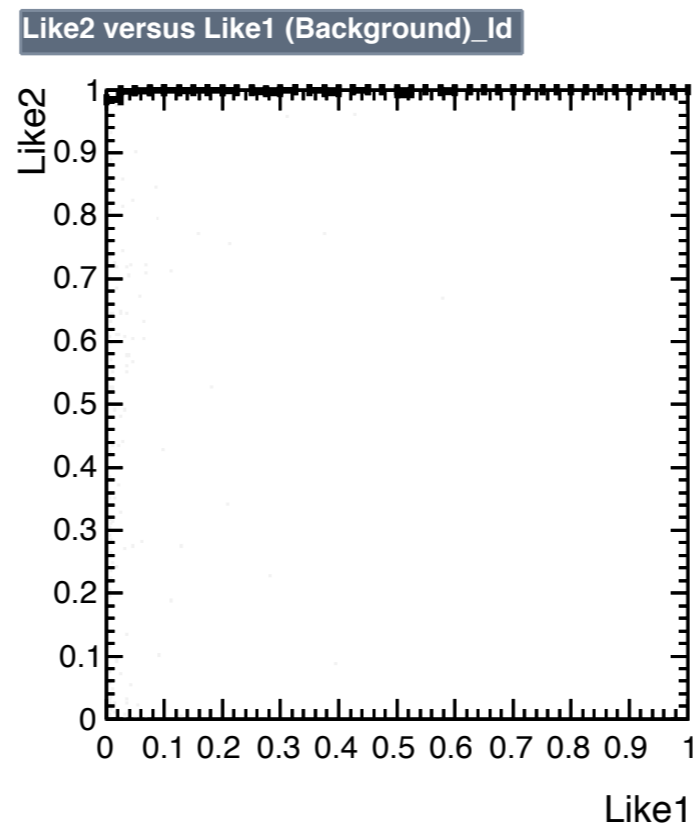
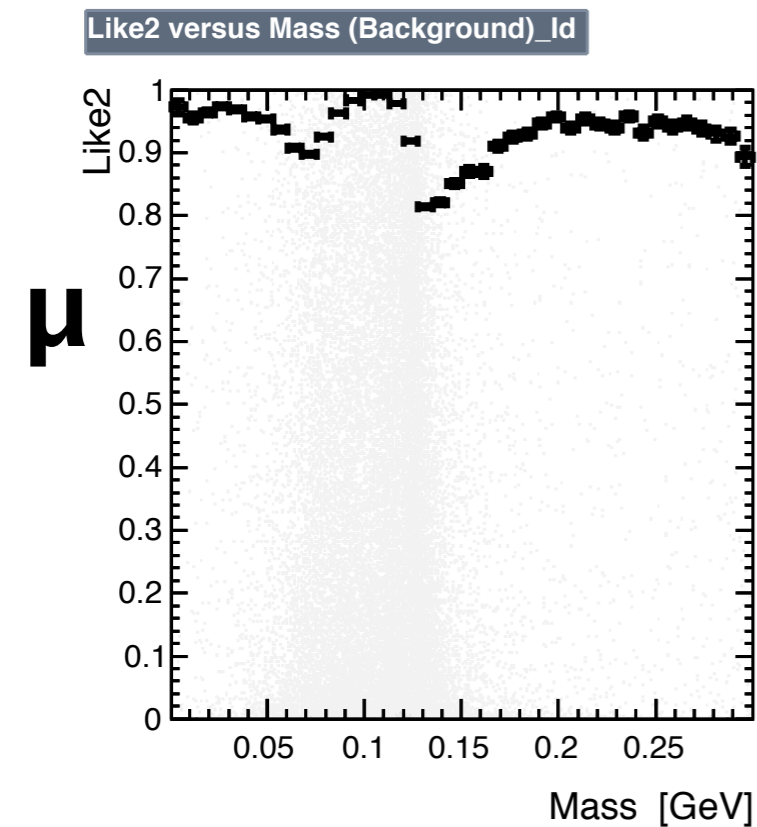
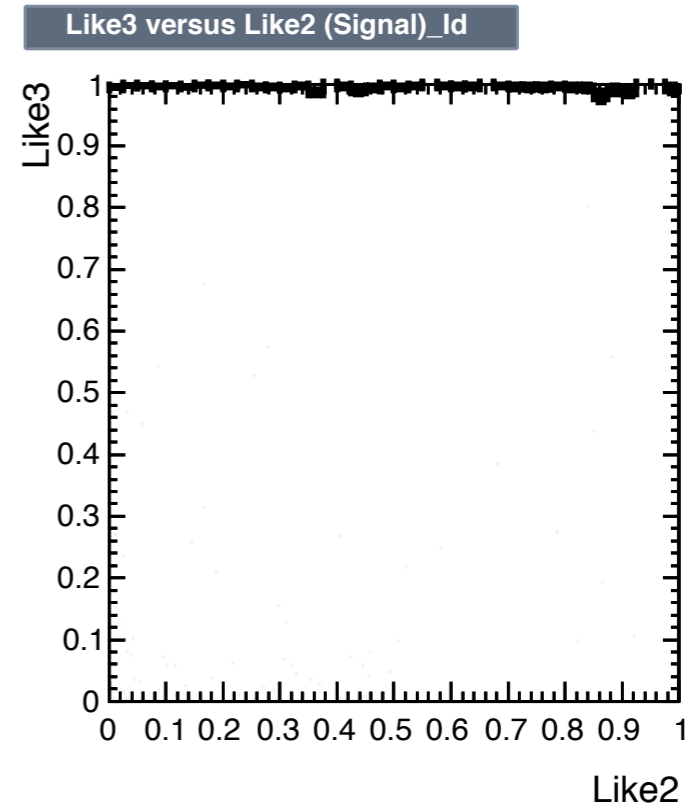
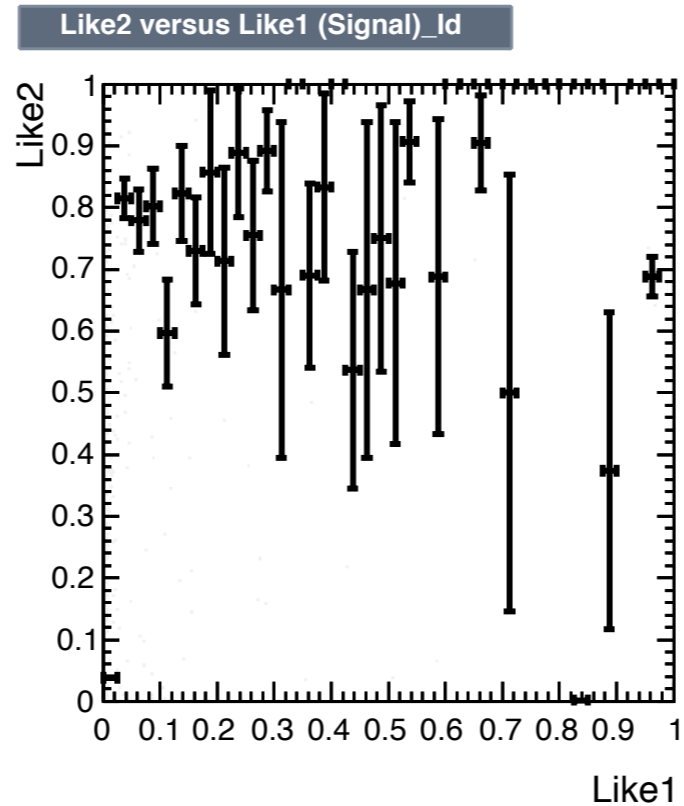
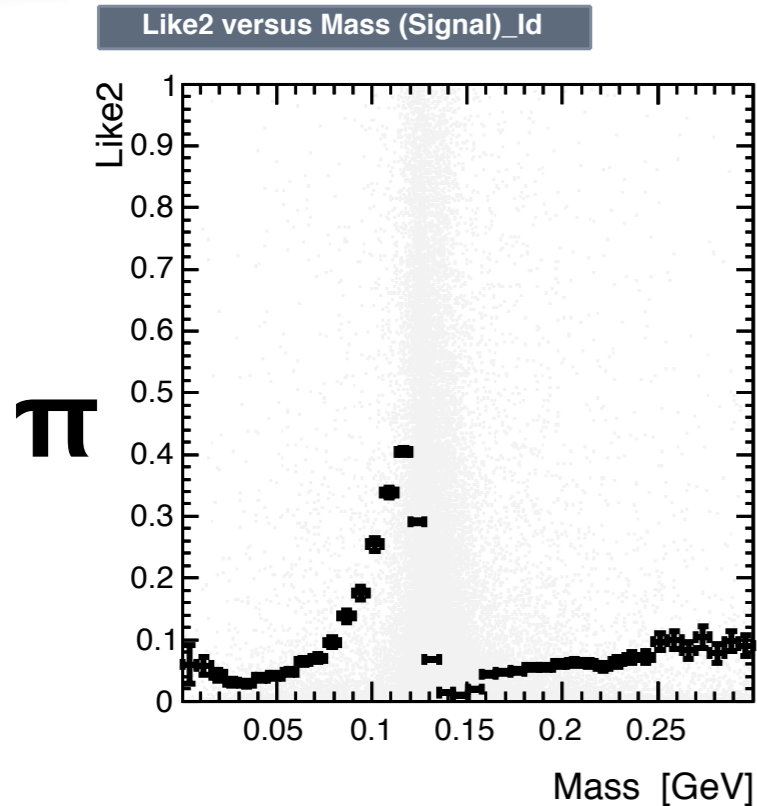


profile Like2 versus Mass (Background)_Id



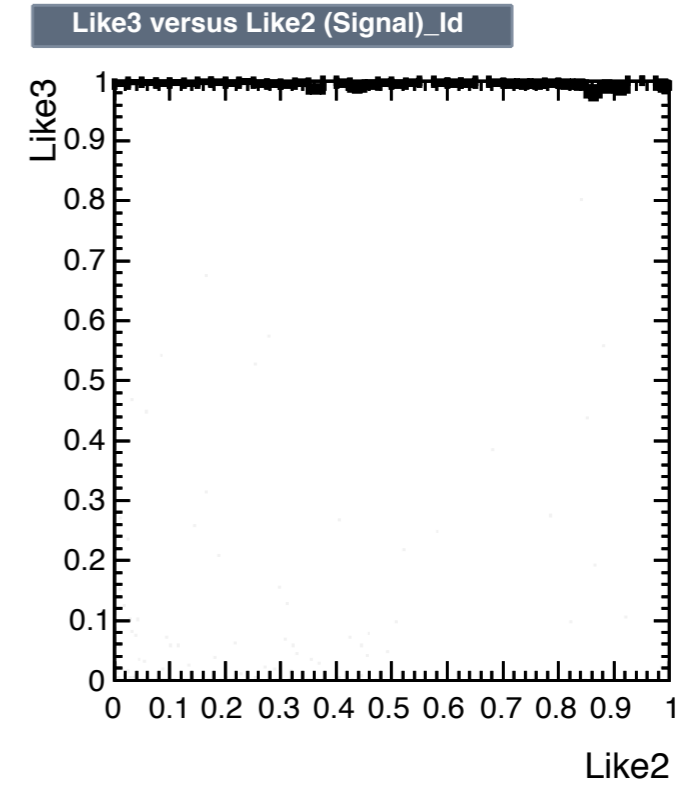
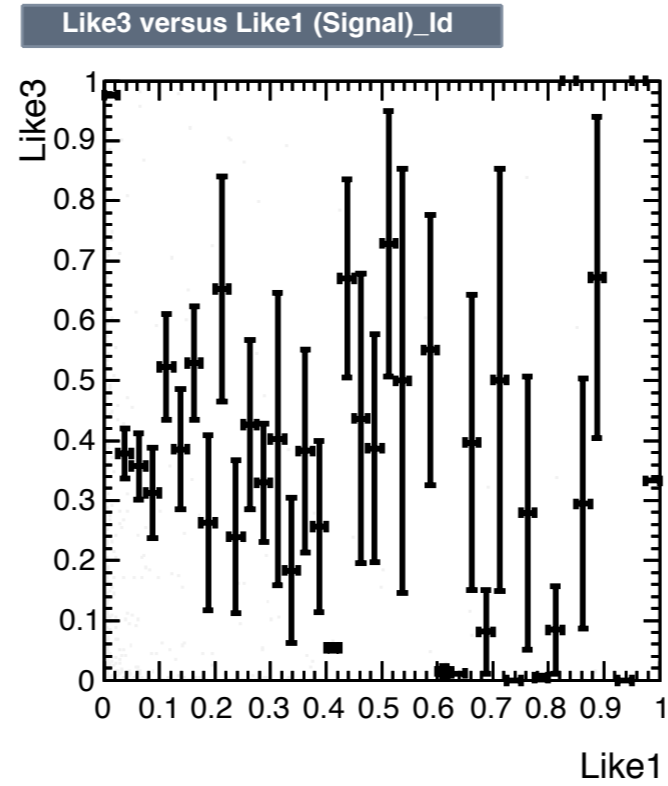
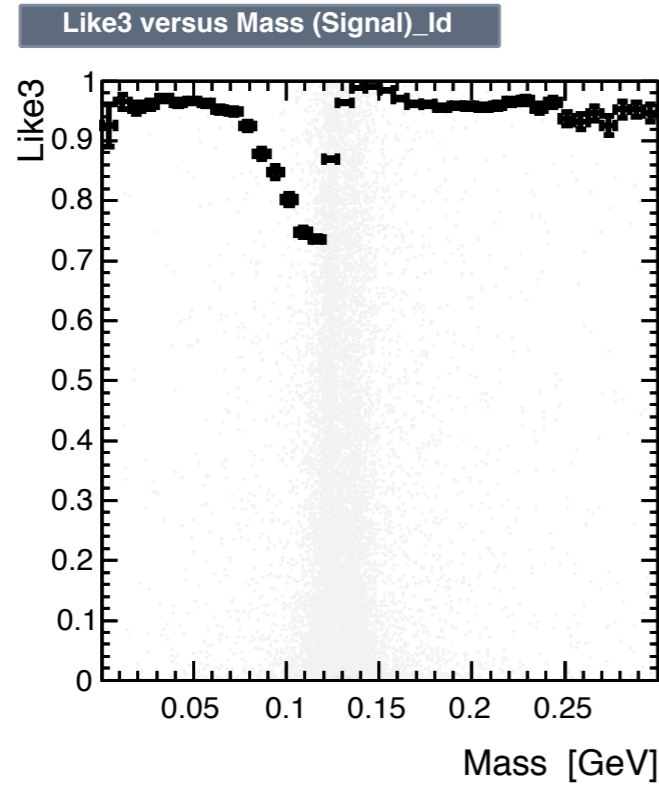
μ

correlations

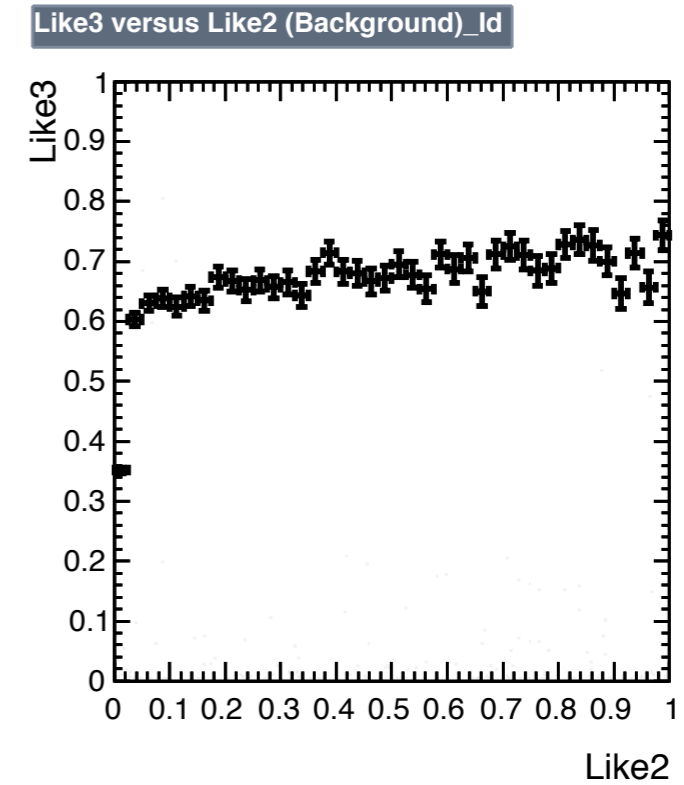
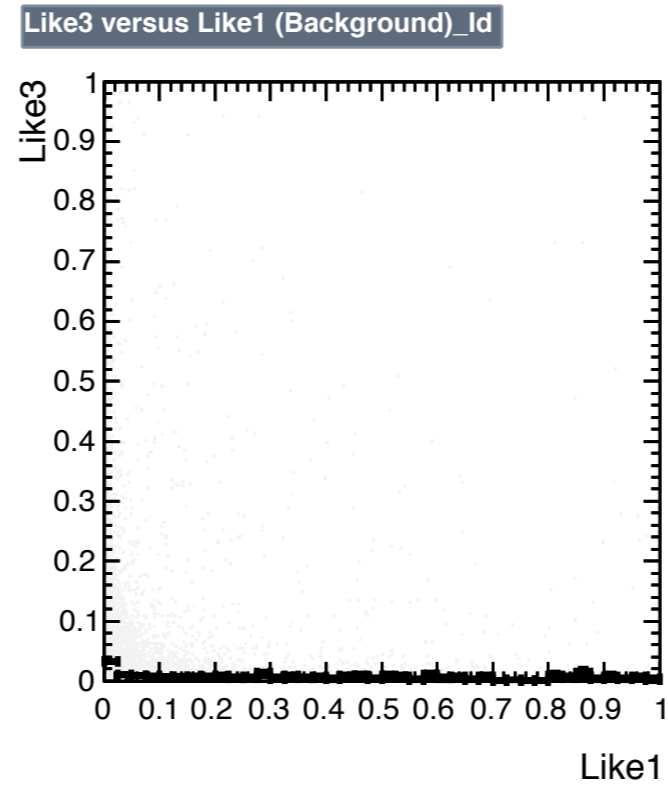
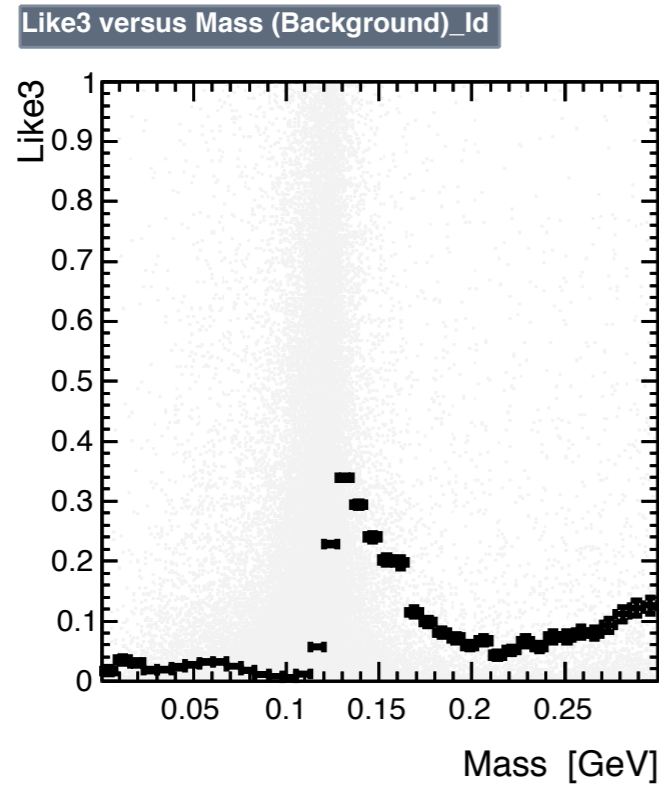


correlations

π

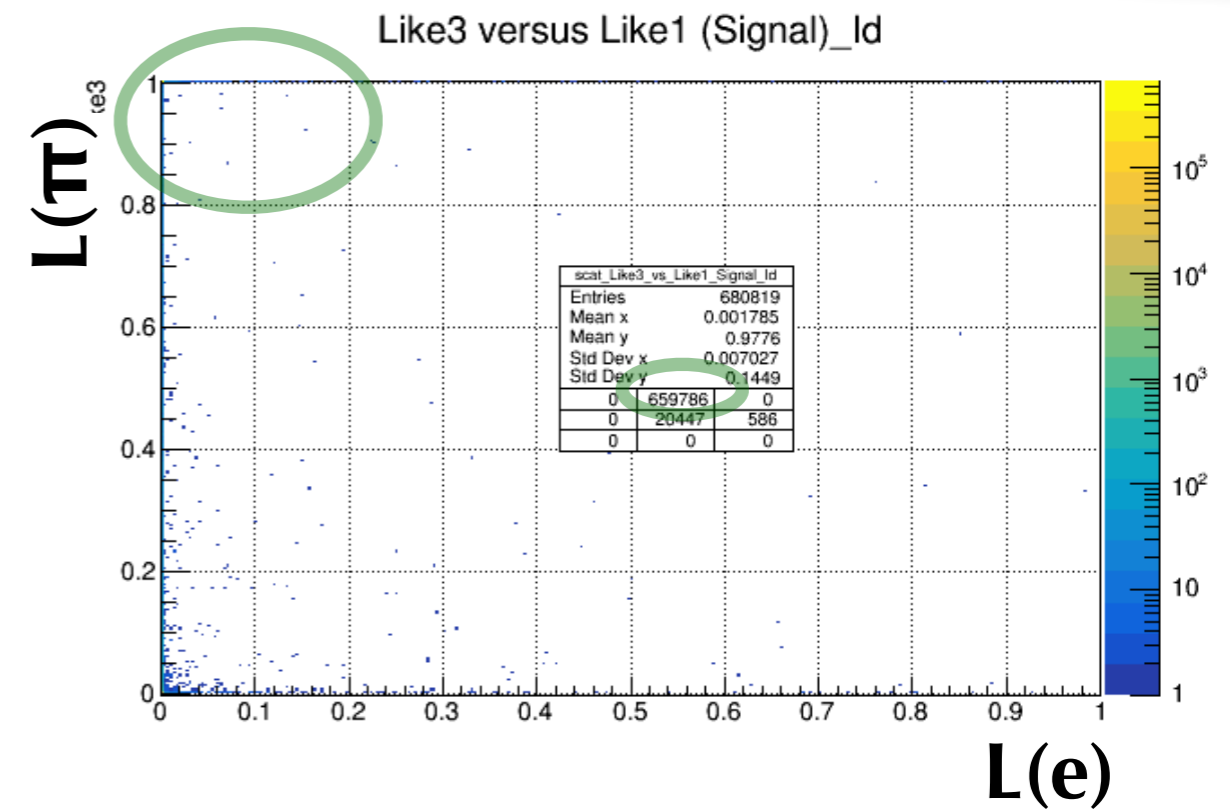
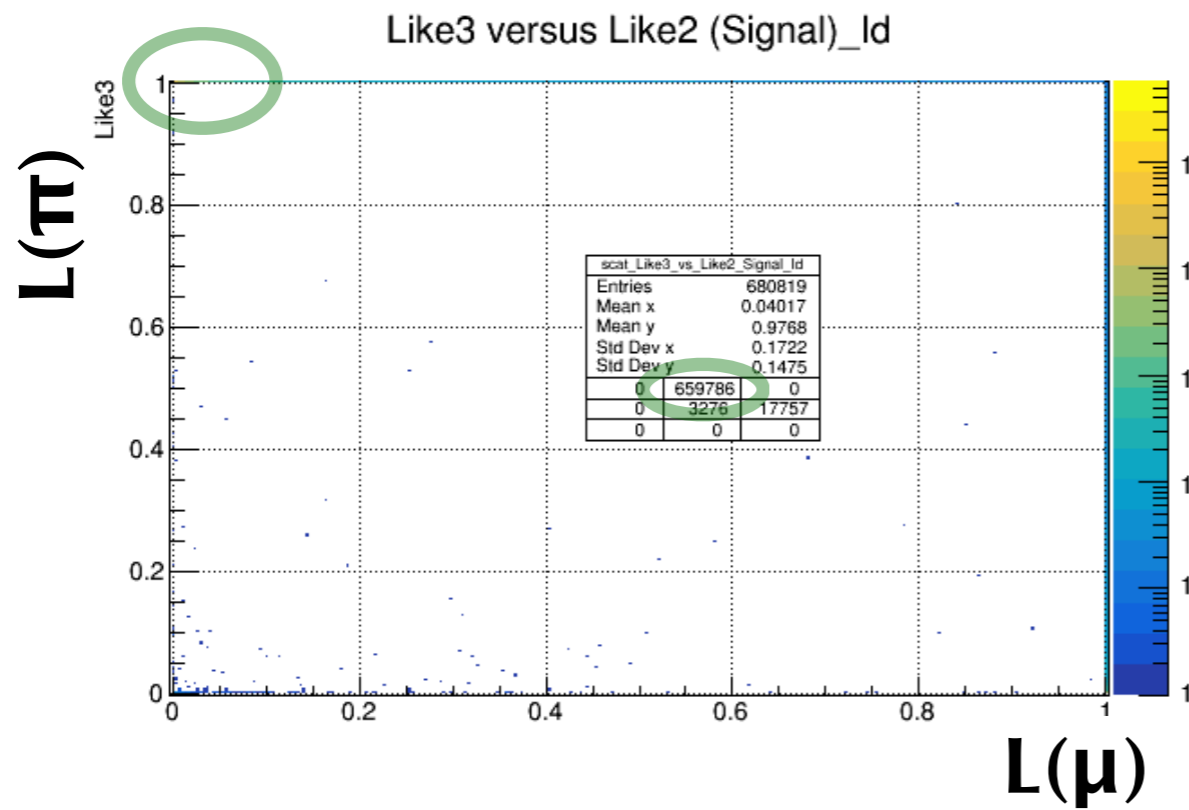


μ

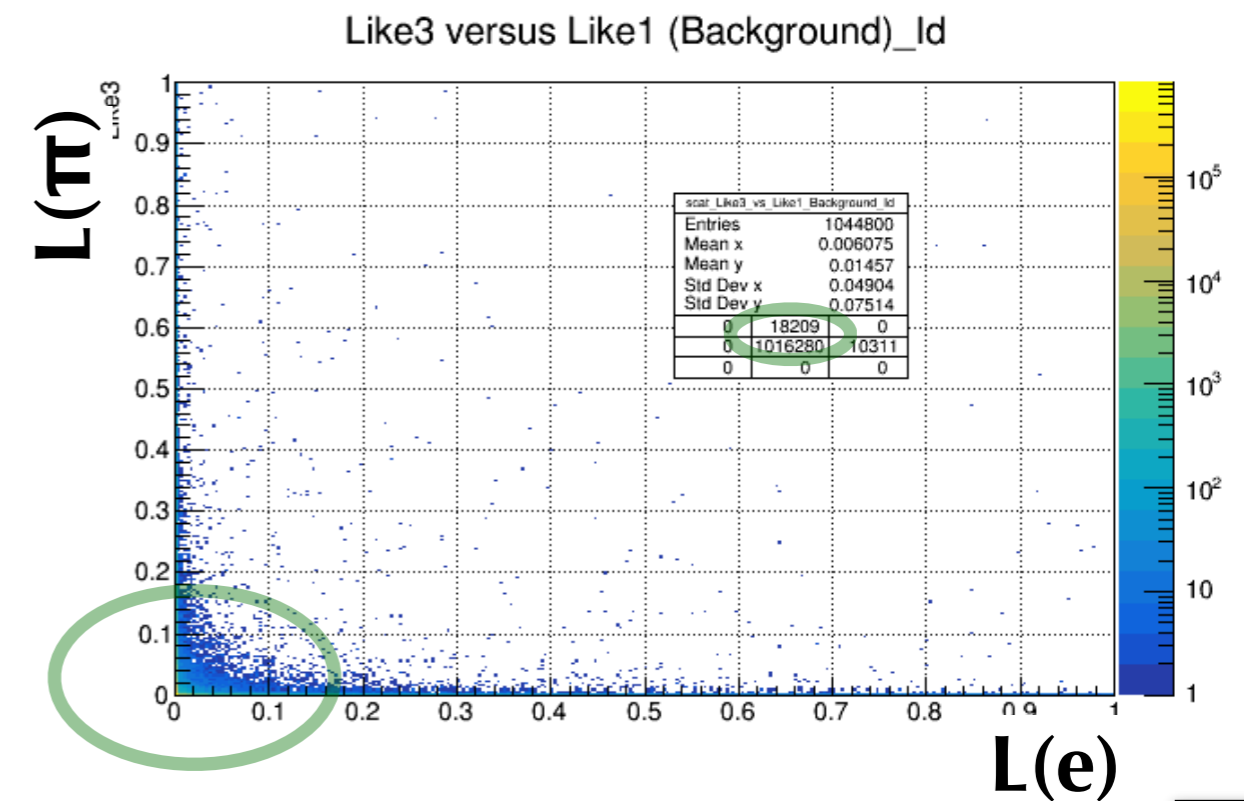
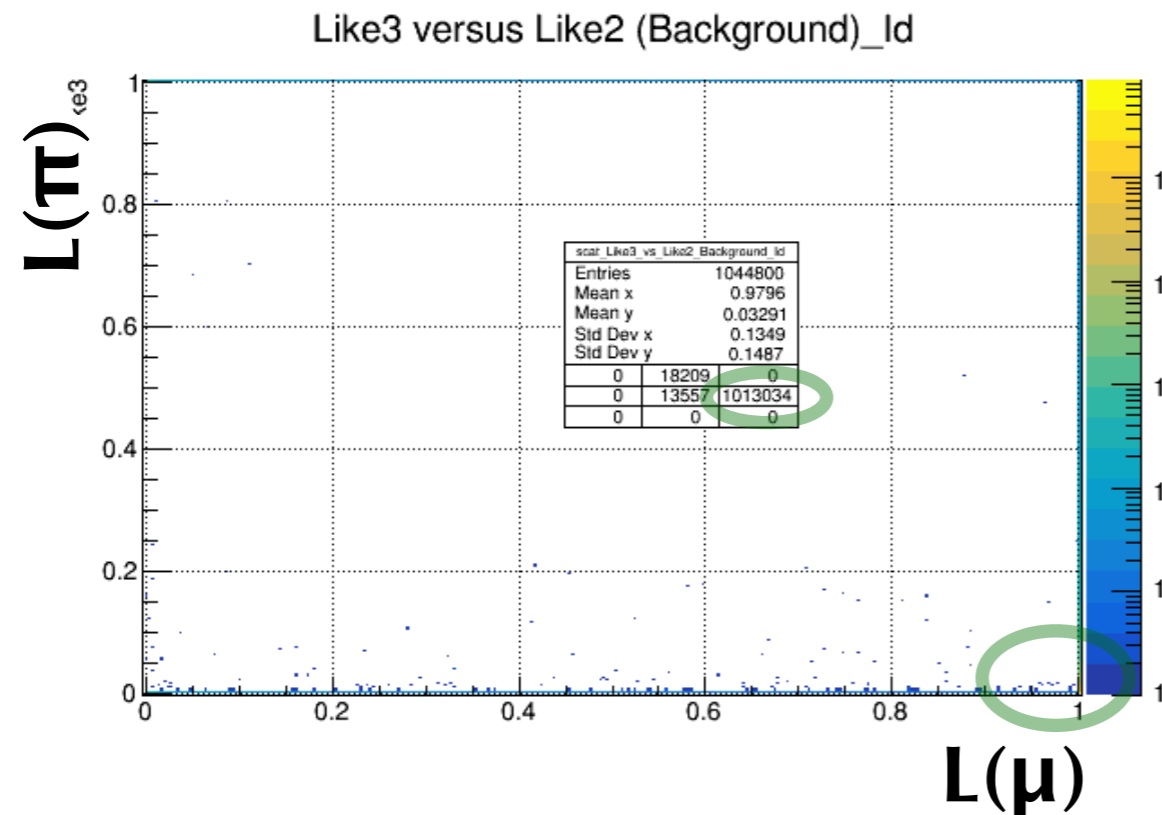


correlations

π



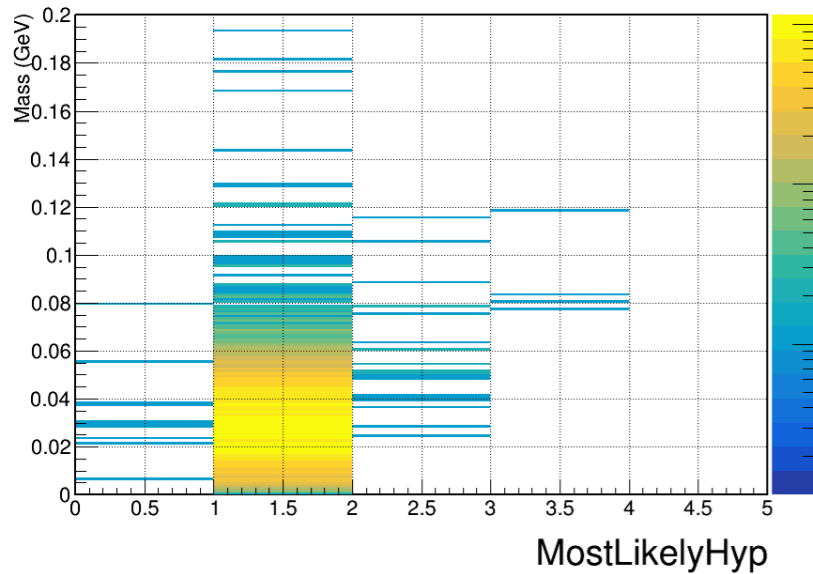
μ



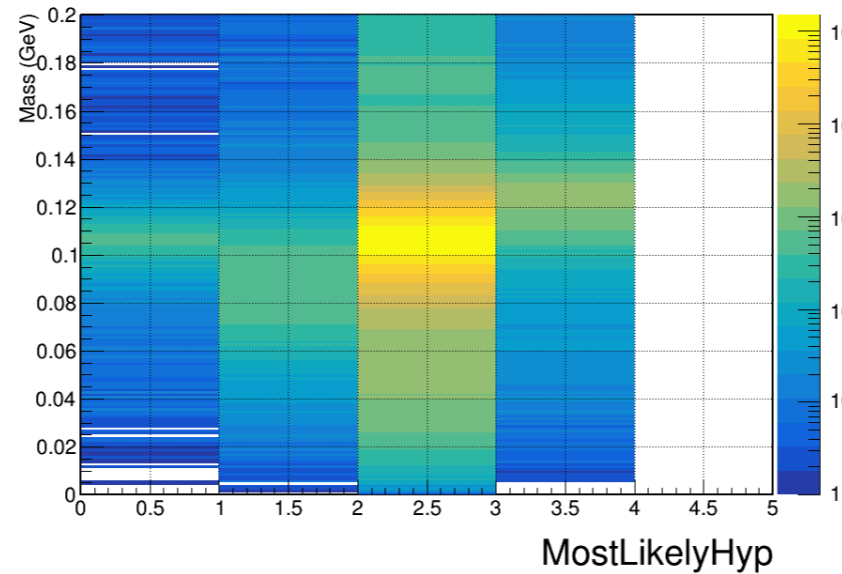
Cuts on likelihood

Most likely hypothesis = 3 (pion) (the most effective cut)

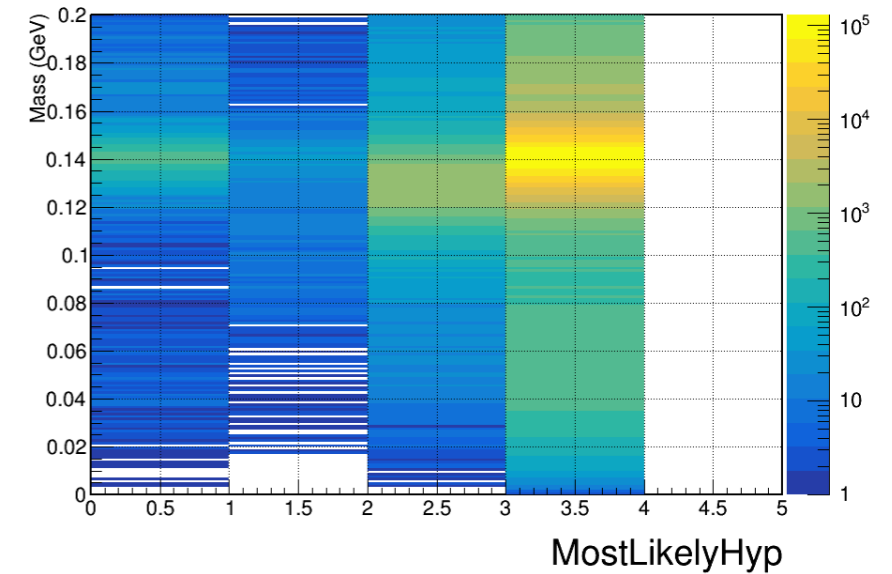
$\pi^0 e^+ \nu$



$\mu^+ \nu$



$\pi^+ \pi^0$

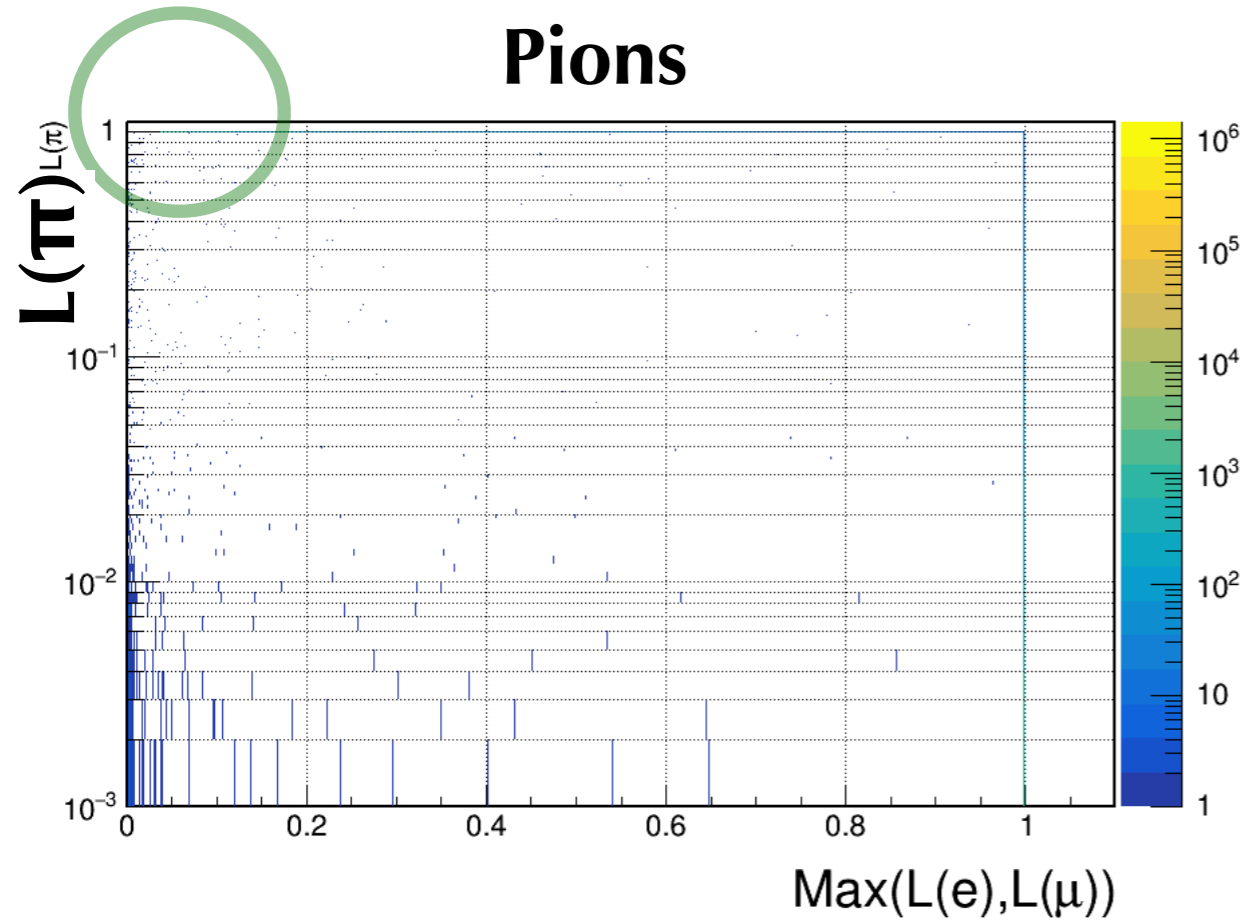


E μ π

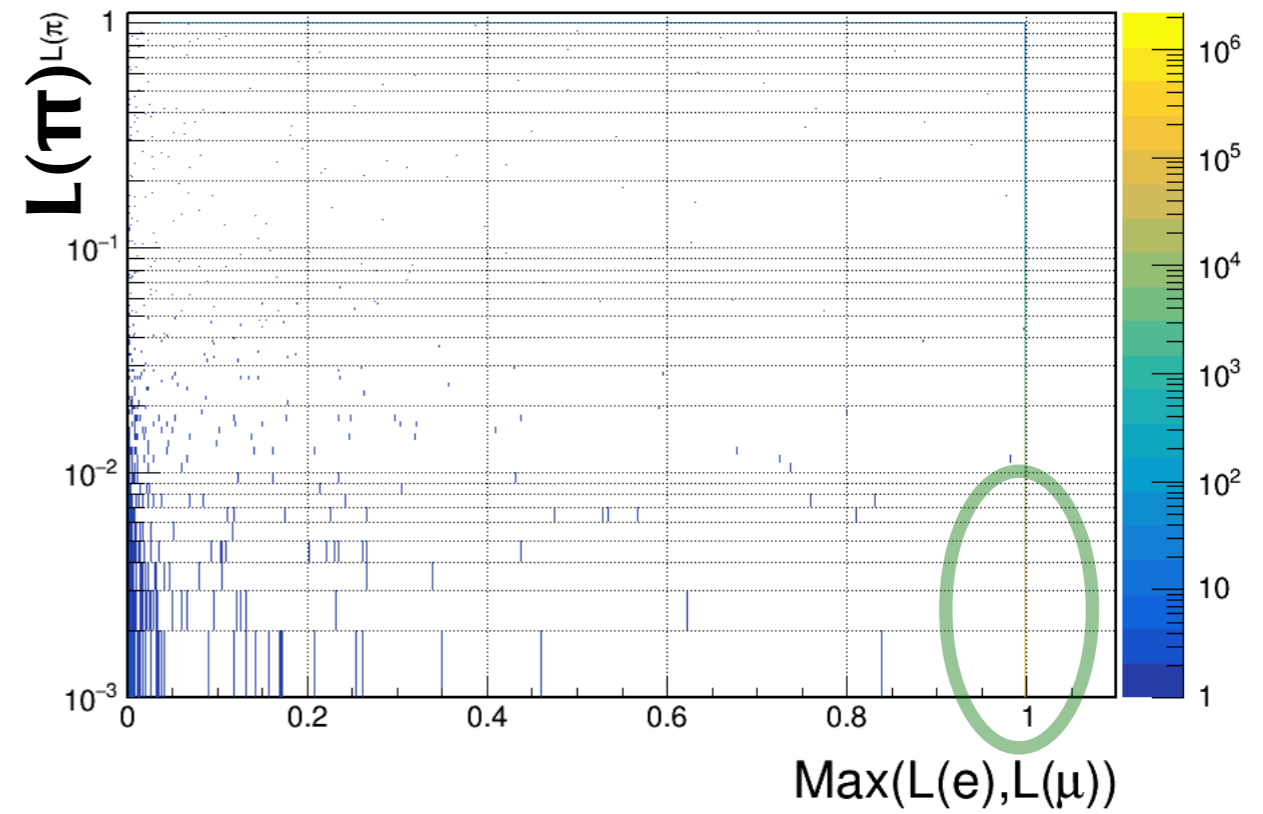
$$L(\pi) / \max(L(\mu), L(e)) > 1.2 \longrightarrow \max(L(\mu), L(e)) / L(\pi) < 0.83$$

Cuts on likelihood

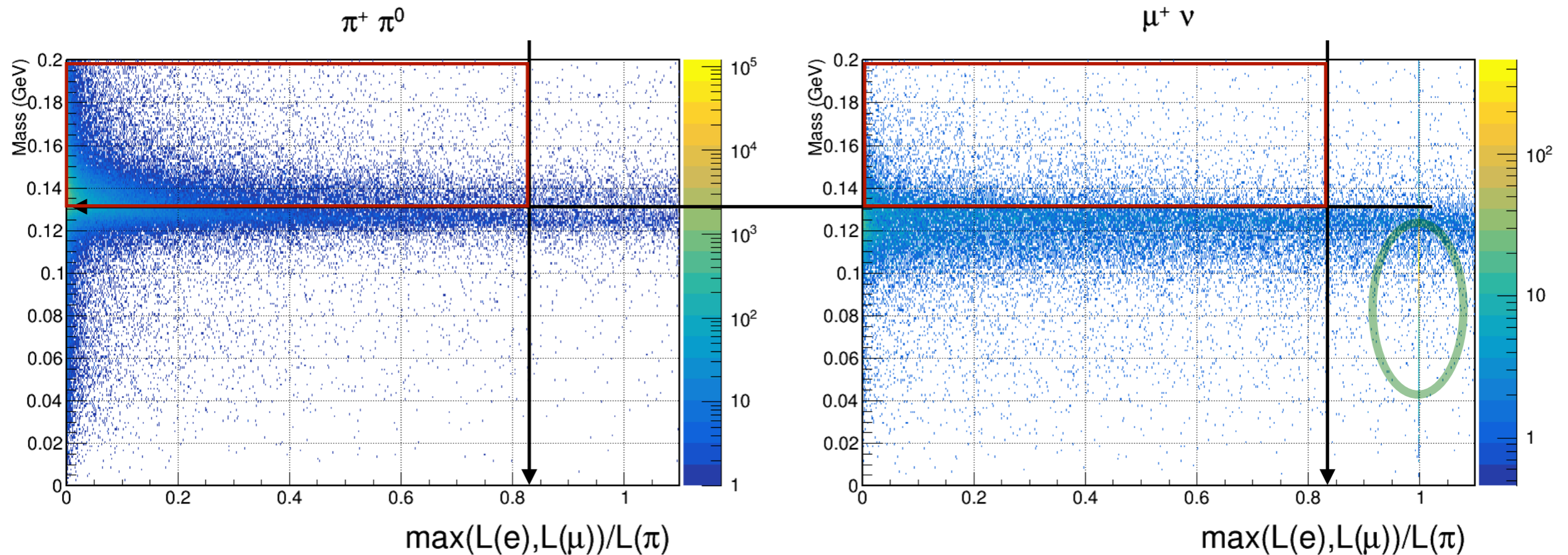
Pions



Muons



Cuts on likelihood and mass

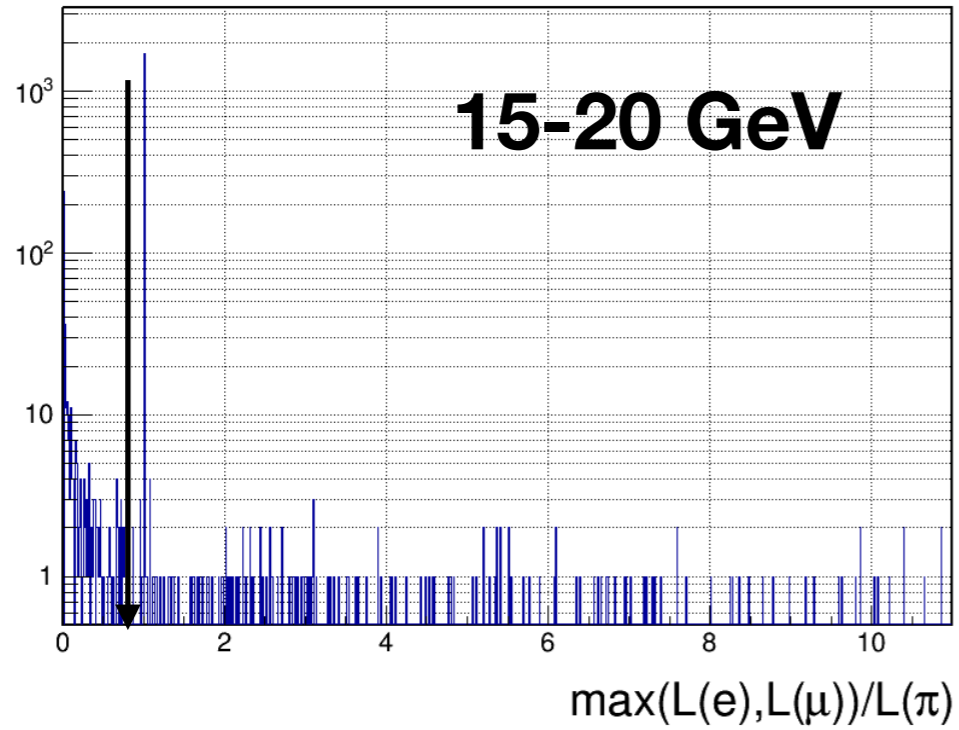


Peak at LikeRatio=1 for $L(\pi)=L(\mu)=L(e) \sim 0$

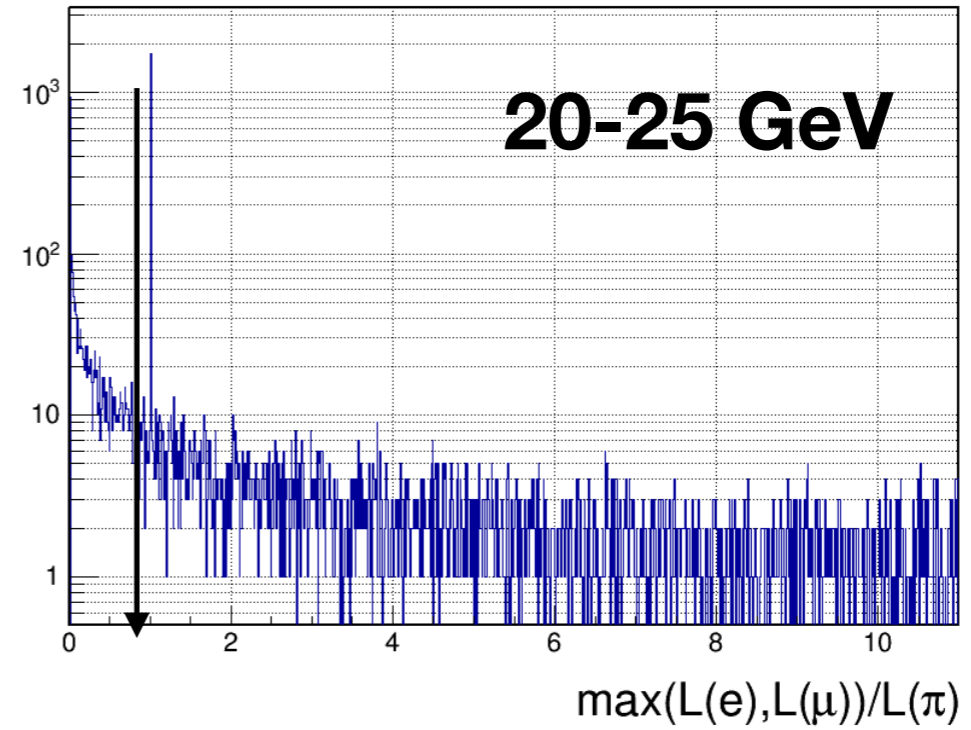
Need to check what happens in the Likelihood algorithm and maybe cut them away earlier.

Muons

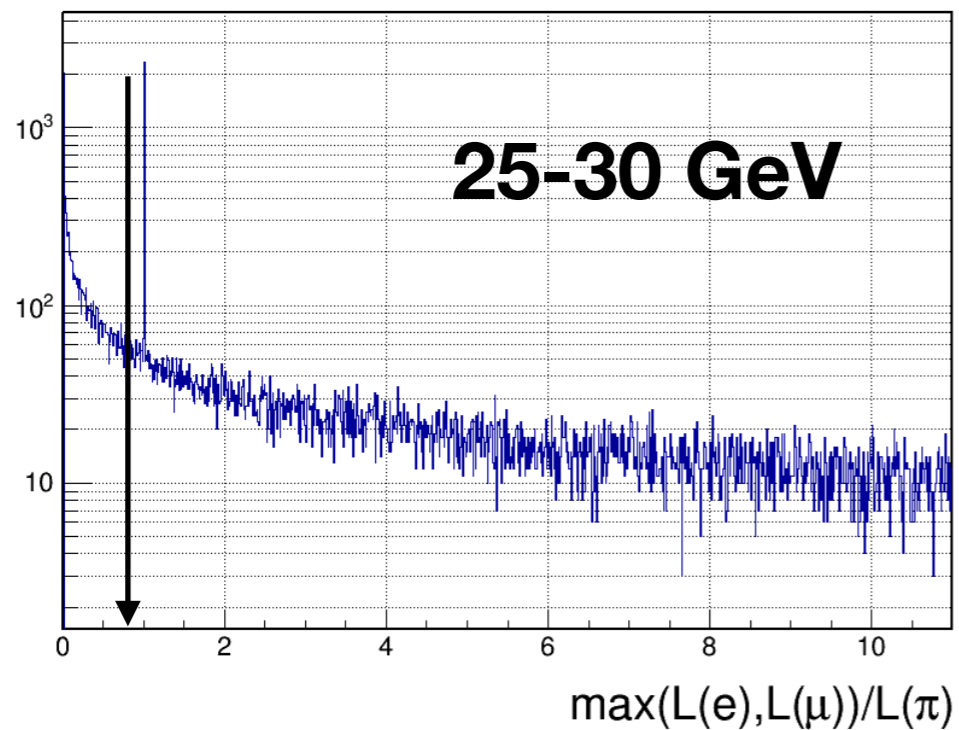
$\mu^+ \nu$



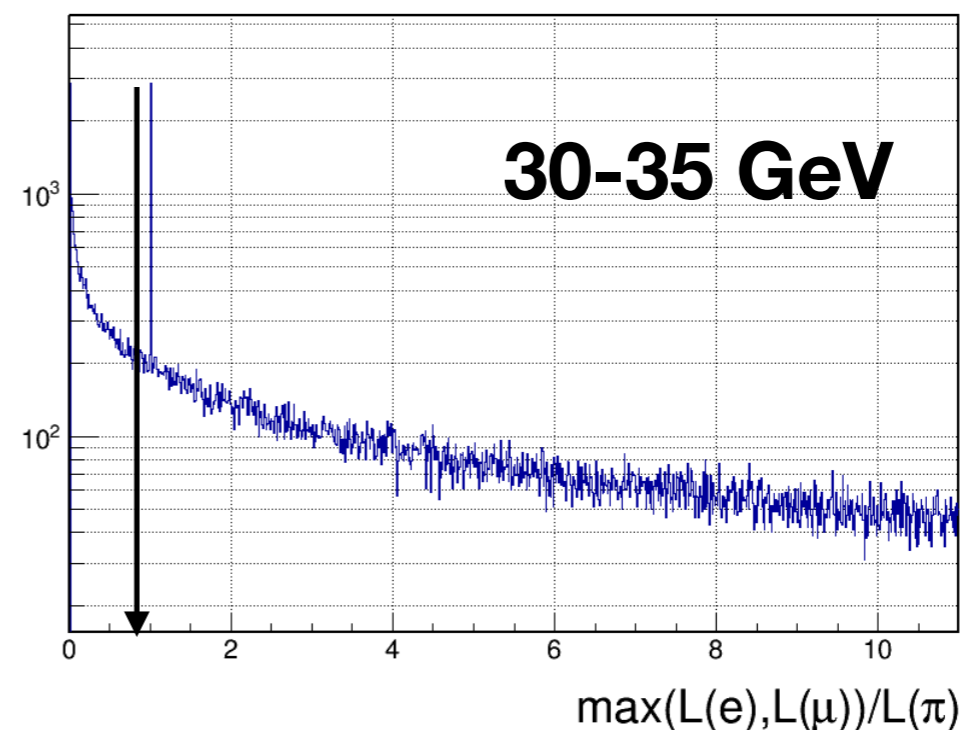
$\mu^+ \nu$



$\mu^+ \nu$

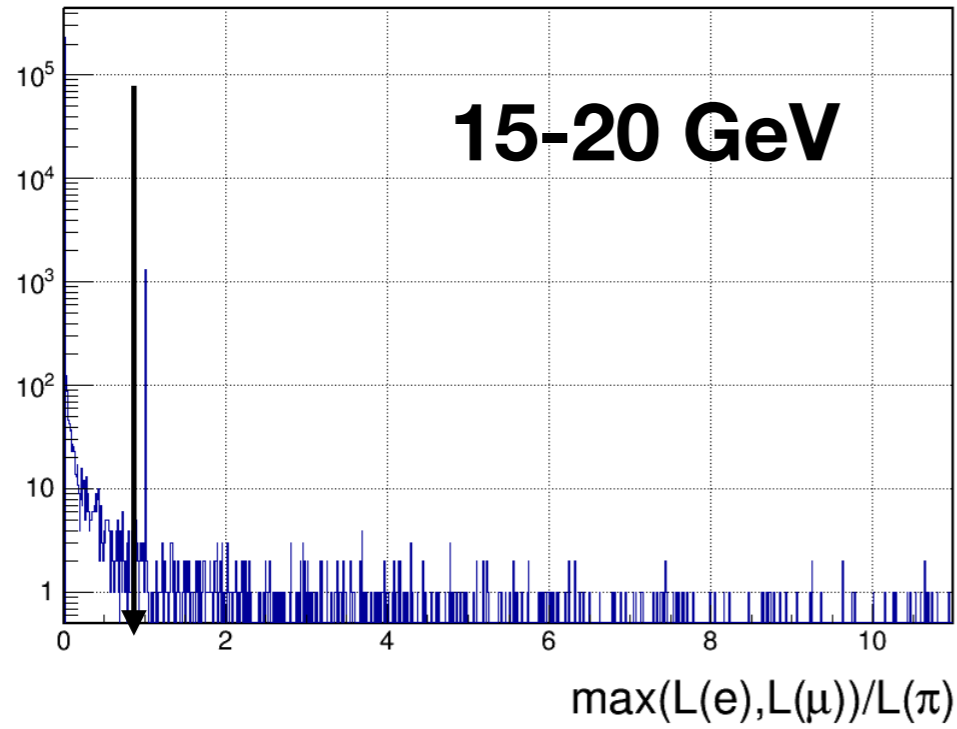


$\mu^+ \nu$

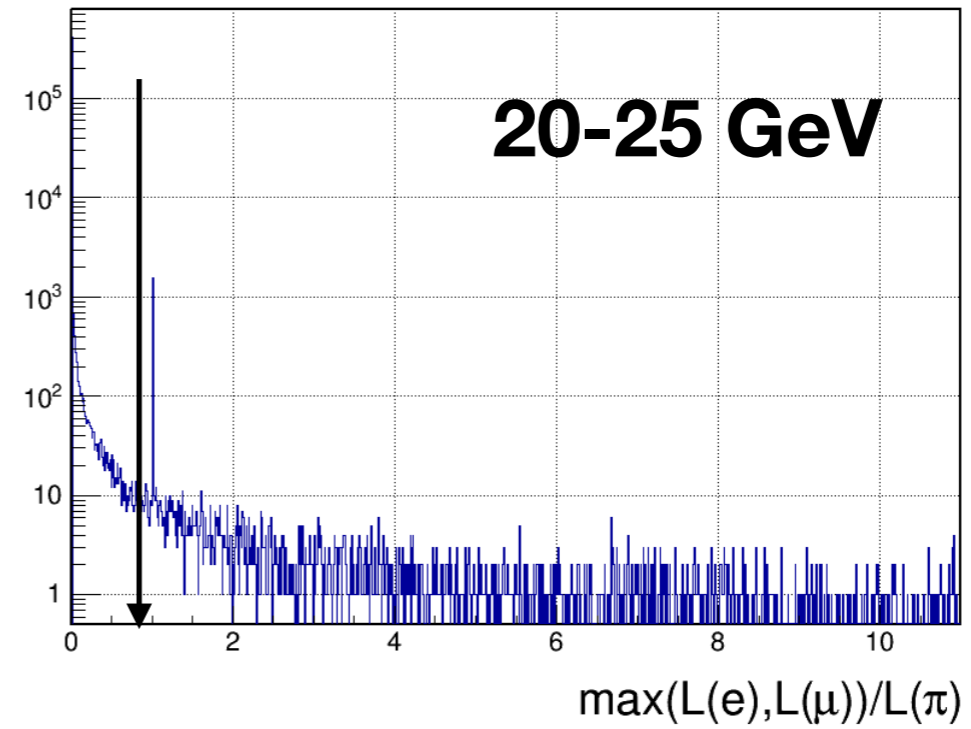


Pions

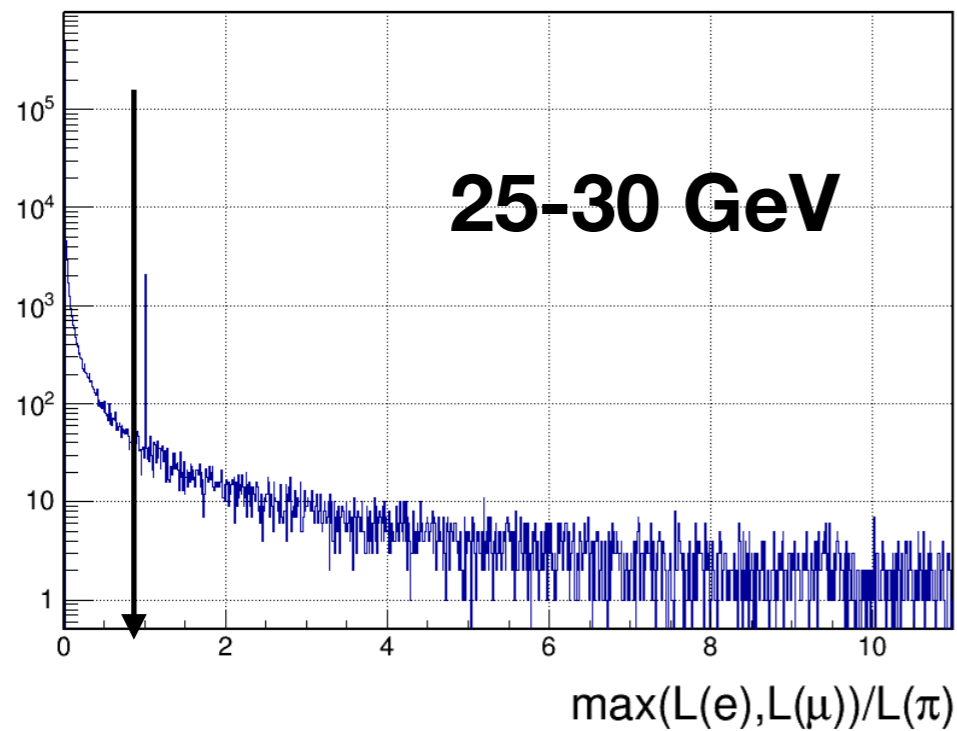
$\pi^+ \pi^0$



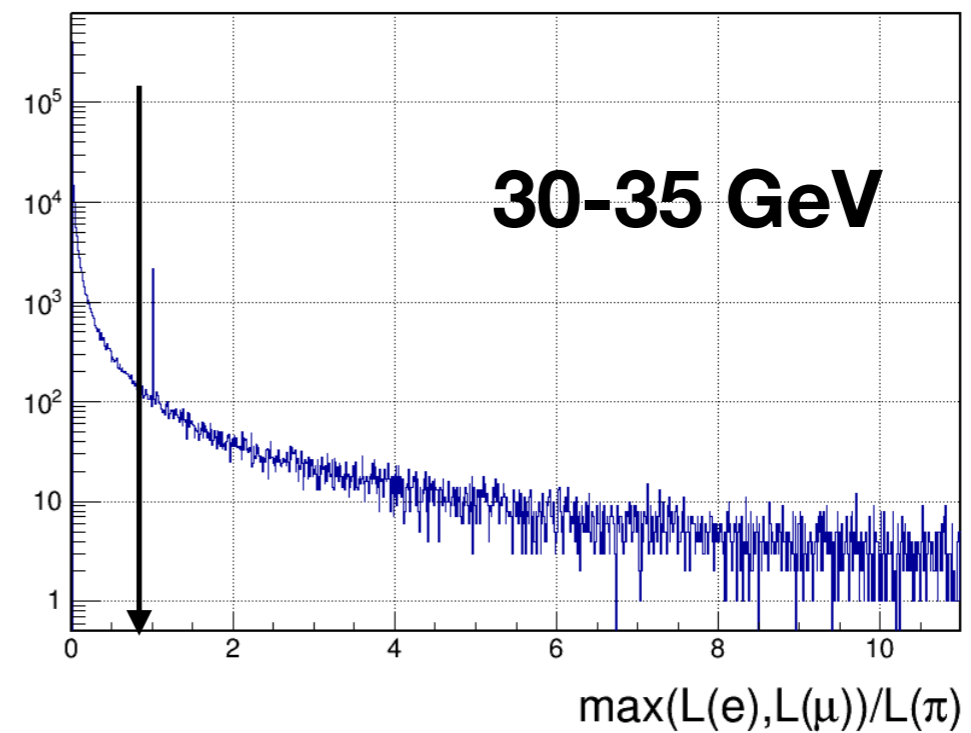
$\pi^+ \pi^0$



$\pi^+ \pi^0$



$\pi^+ \pi^0$



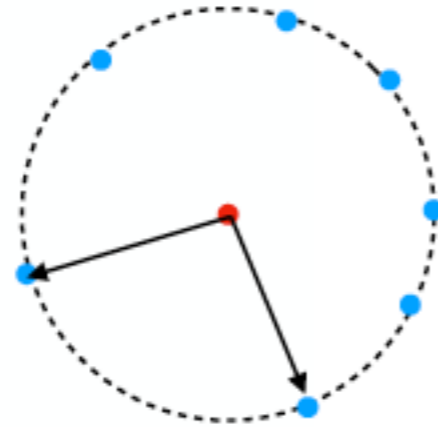
Variables

Mass

Like1= RICHLikelihood(e)
Like2= RICHLikelihood(mu)
Like3= RICHLikelihood(pion)

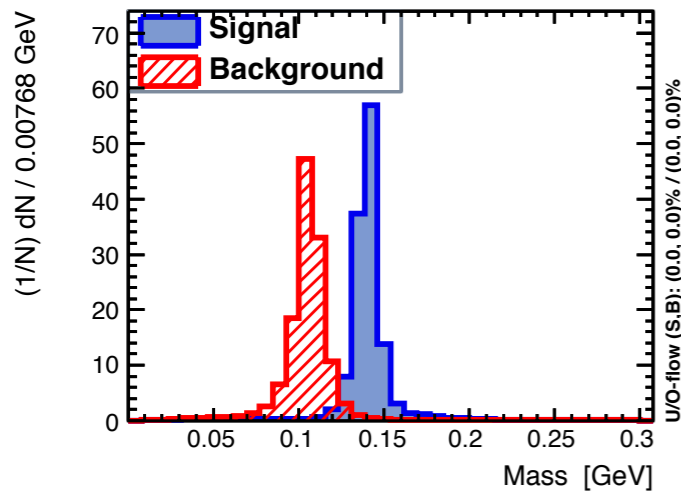
Chi2Prob
MaxDeltaPhi

MaxDeltaPhi
(Francesco&Mauro)

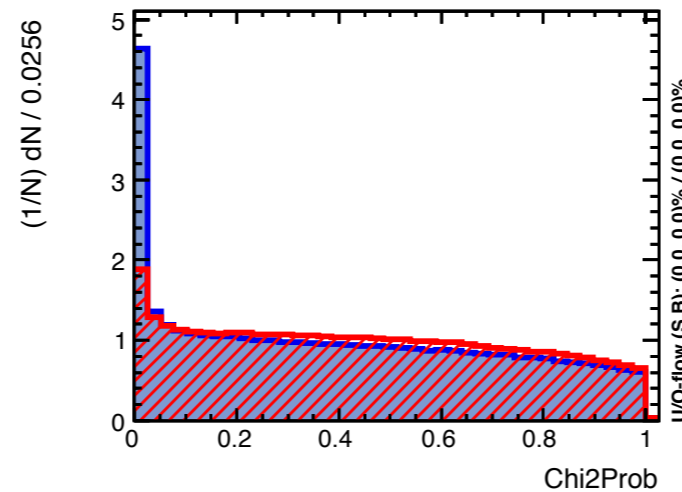


Chi2Prob: probability of χ^2 of the ring fit

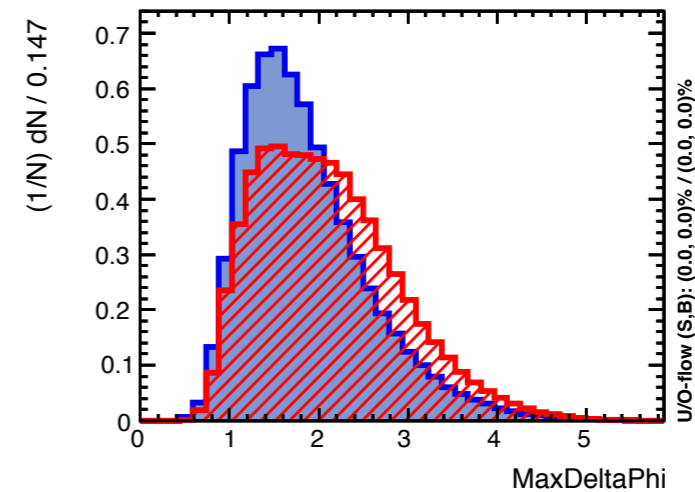
Input variable: Mass



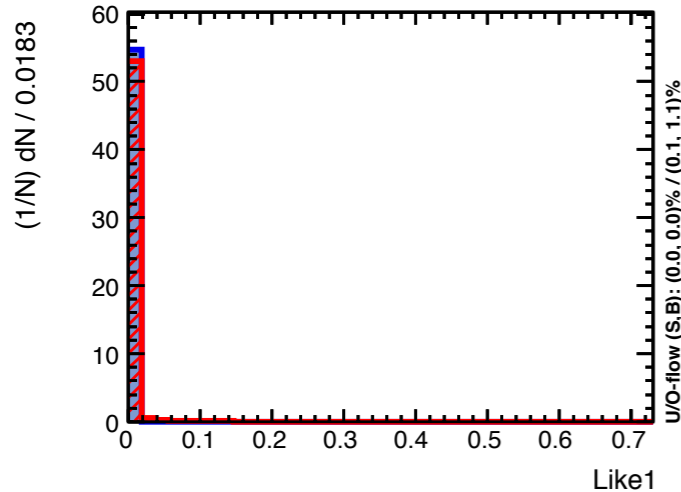
Input variable: Chi2Prob



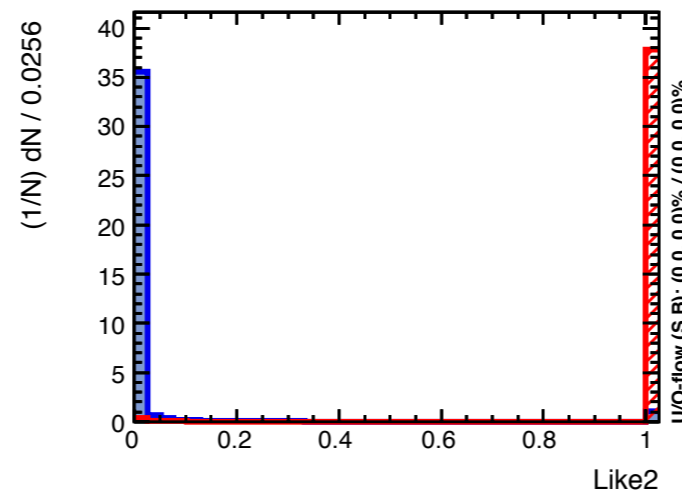
Input variable: MaxDeltaPhi



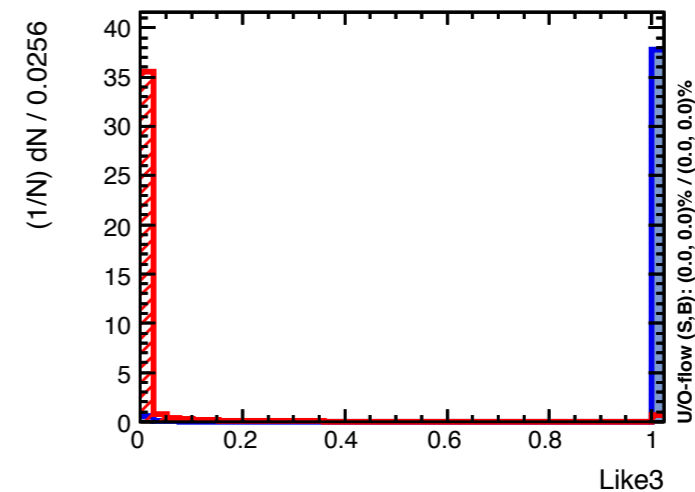
Input variable: Like1



Input variable: Like2



Input variable: Like3



4 momentum bins

Mass

Like1 = RICHLikelihood(e)
Like2 = RICHLikelihood(mu)
Like3 = RICHLikelihood(pion)

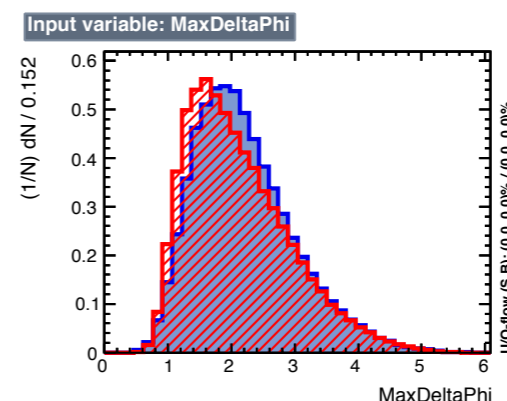
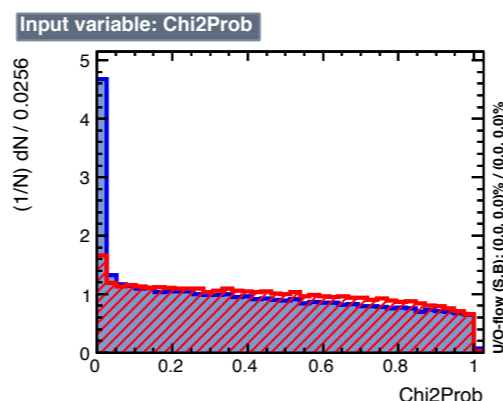
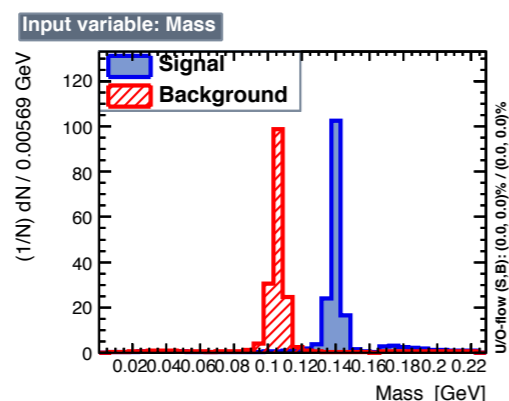
Chi2Prob
MaxDeltaPhi

Mass

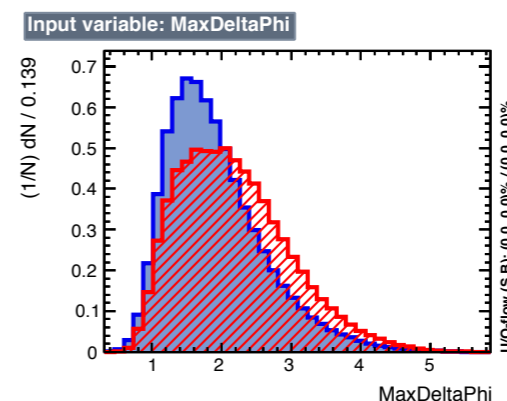
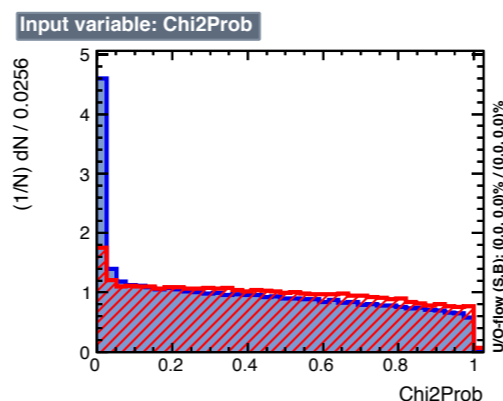
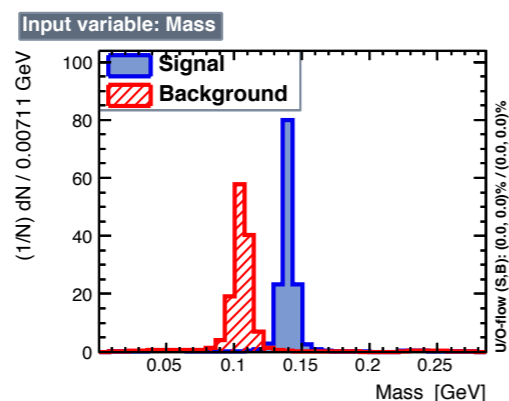
Chi2Prob

MaxDeltaPhi

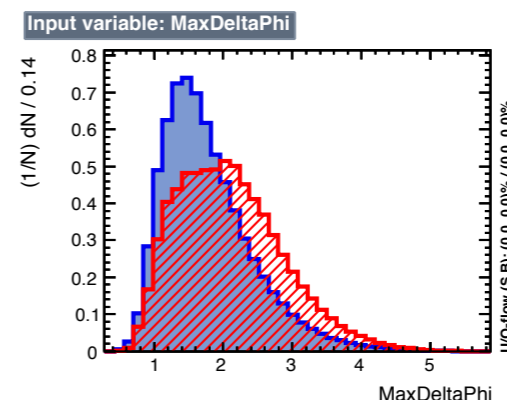
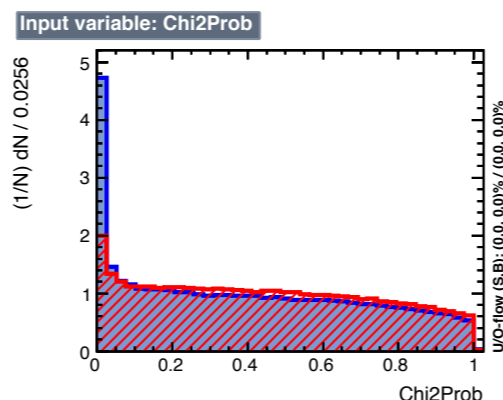
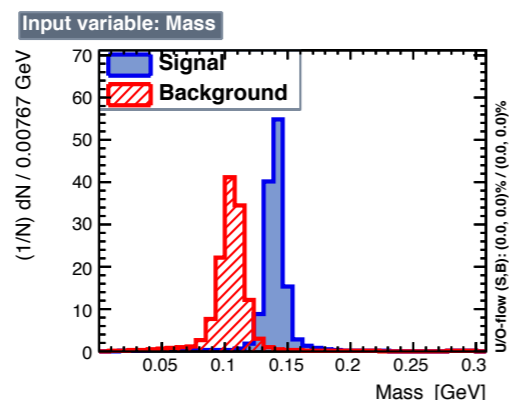
15-20 GeV



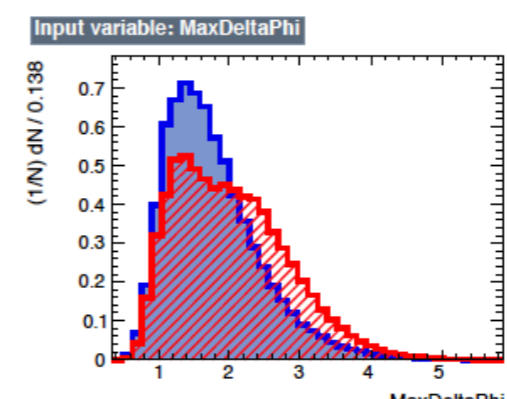
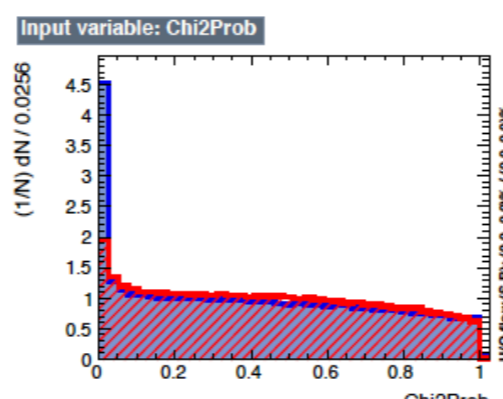
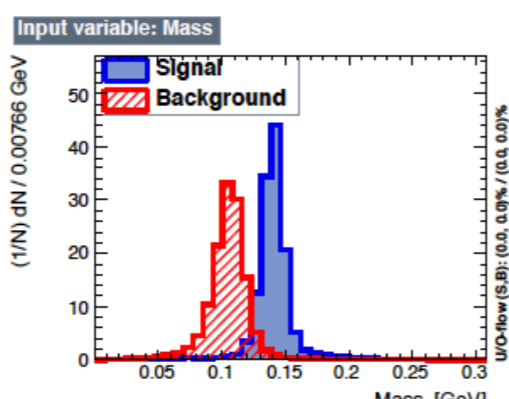
20-25 GeV



25-30 GeV



30-35 GeV

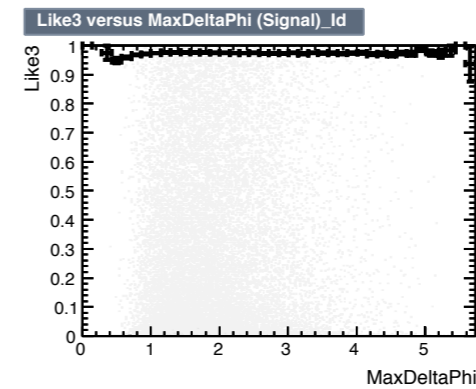
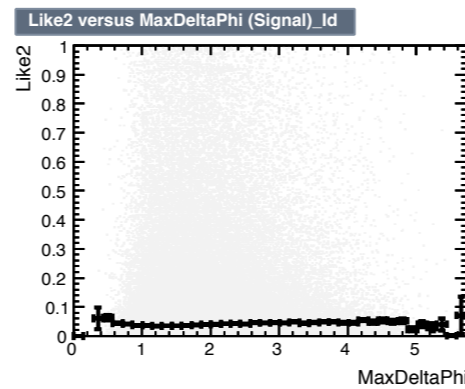
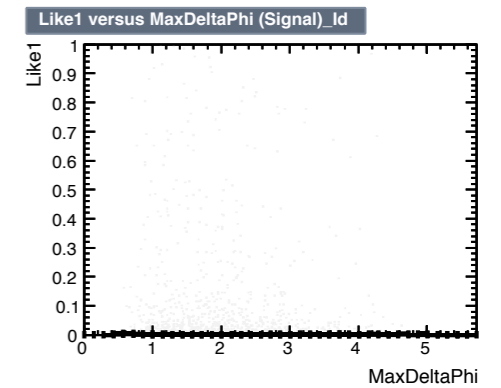
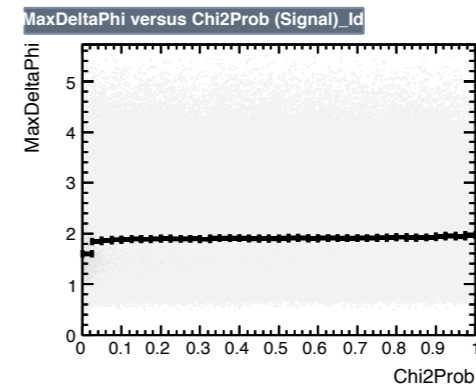
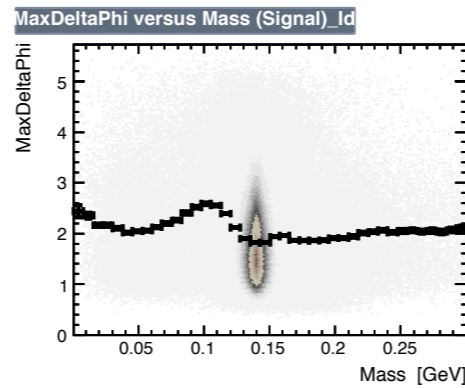


Variable correlations

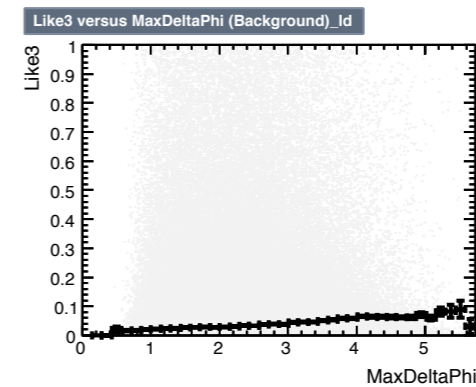
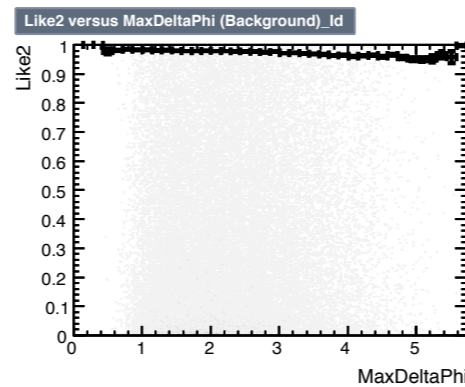
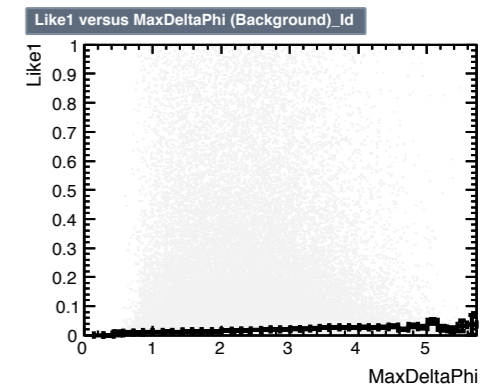
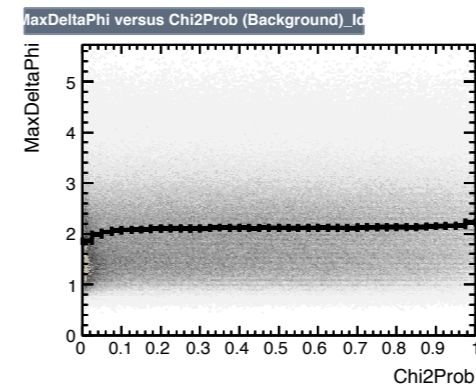
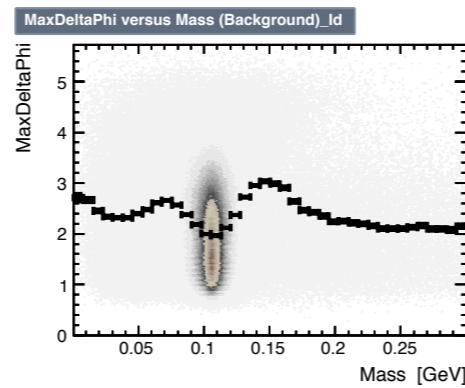
Like1= RICHLikelihood(e)
Like2= RICHLikelihood(mu)
Like3= RICHLikelihood(pion)

Mass
Chi2Prob
MaxDeltaPhi

Signal (pions)



Background (muons)



My short term plan

- **Study in more detail the likelihood and try to replace it with a multivariate analysis**